SCIENCE

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EDWARD D. COPE.

NATURAL science and philosophy have sustained a heavy loss in the premature death of Professor Edward D. Cope. His work began at a most favorable time, in 1859, when comparative anatomy first felt the impetus of the 'Origin of Species,' and for thirty-eight years his active mind has been hastening our progress in no less than five great lines of research. In each his inspiring example and leadership will be sadly missed. He passed away upon April 12th, at the age of fifty-seven, in the full vigor of his intellectual powers, leaving a large part of his work incomplete. Almost at the last he contributed several reviews to the *Naturalist*, and upon the Tuesday preceding his death he sent to the press an elaborate outline of his University lectures containing his latest ideas of the classification of the Vertebrata. For two months his health had been affected by a serious disorder, which might possibly have been remedied by a surgical operation. This was unfortunately postponed until it was too late, and the end came so suddenly that his family decided not to remove him from his house, in Pine Street, which was both his study and museum. He thus passed away in the scene of his life work, surrounded by his fossils and books. A gathering of his scientific friends in his memory also took place here a few days later. His will proves to be consistent with his life, as he leaves

all his rare scientific treasures for the benefit of the Philadelphia Academy of Sciences and the University of Pennsylvania. It is hoped that the following sketch of his early life and brief review of his principal writings will give some idea of his genius and of his position in the world of science.

Edward Drinker Cope was born in Philadelphia, July 28, 1840, of distinguished American ancestry.* His great-grandfather, Caleb Cope, is said to have been the staunch Quaker of Lancaster, Pa., who protected Major Andre from mob violence. Thomas Pim Cope, his grandfather, founded the house of Cope Brothers, famous in the early mercantile annals of Philadelphia. His father was Alfred, the junior member of the firm, a man of very active intellect, who showed rare judgment in Edward's education. Together the father and son became brisk investigators, the father stimulating by questions and by travel the strong love of nature and of natural objects which the son showed at an unusually early age.

In August, 1847, they took a sea voyage to Boston, and the son's journal is full of drawings of jellyfish, grampuses and other natural objects seen by the way. When eight and a half years old he made his first visit to the Museum of the Academy of Natural Sciences, 'on the 21st day of the 10th Mo., 1848,' as entered in his journal; he brought away careful drawings, measurements and descriptions of several larger birds, but especially the figure of the entire skeleton of an Icthyosaur, with this quaint memorandum: "Two of the sclerotic plates look at the eye—thee will see these in it." At the age of ten he was taken upon a longer voyage to the West Indies. Thus the child was in a remarkable degree the father of the man. The principal impression he gave in boyhood was of incessant activity in mind and body, of quick and ingenious thought, reaching in every direction for knowledge, and of great independence in character and action. It is evident that he owed far more to paternal guidance in the direct study of nature and to his own impulses as a young investigator than to the five or six years of formal education which he received at school. He was especially fond of map drawing and of geographical studies. His natural talent for languages may have been cultivated in some degree by his tutor, Dr. Joseph Thomas, an excellent linguist, editor of a biographical dictionary. Many of his spare winter hours were passed at the Academy. After the age of thirteen the summer intervals of boarding school life and later of tutoring were filled among the woods, fields and streams of Chester county, Pa., where an intimate knowledge of birds was added to that of batrachians, reptiles and insects. He always showed a particular fondness for snakes. One of these excursions, taken at the age of nineteen, is described in a letter to his cousin (dated June 24, 1859); at the close of a charming description of the botany of the region appears his discovery of a new type:

"I traced the stream for a very considerable distance upon the rocky hillside, my admiration never ceasing, but I finally turned off into the woods towards some towering rocks. Here I actually got to searching for Salamanders and was rewarded by capturing two specimens of species which I never before saw alive. The first (*Spelerpes longicauda*) is a great rarity here. I am doubtful of its having been previously noted in Chester county. Its length is 6 inches, of which its tail forms nearly four. The color is deep brownish yellow, thickly spotted with black, which becomes confluent on the tail, thus forming bands. To me a very interesting animal—the type of the genus *Spelerpes*, and consequently of the subfamily Spelerpinæ, which I attempted to characterize in a paper published in the Proceedings of the Academy of Natural Sciences. I send thee a copy, with

*In the preparation of this article the writer is indebted to several members of Professor Cope's family, also to Professor Bashford Dean and to Professor George Baur. The latter has contributed especially a section upon the Reptilia.

the request that thee will neither mention nor show it,* for—however trifling—I would doubtless be miserably annoyed by some if thee should. Nobody in this country (or in Europe, of *ours*) knows anything about Salamanders, but Professor Baird and thy humble coz., that is in some respects. Rusconi, the only man who has observed their method of reproduction, has written enough to excite greatly one's curiosity and not fully satisfy it. With suitable appliances of aquariums, etc., I should like to make some observations. The other Salamander I caught was *Plethodon glutinosum*—the young—remarkable for the great number of teeth that lie together in two patches on the 'basisphenoid' bone; about 300 or more."

Another passage gives an insight into his strong opinion, so often expressed afterward, as to what constitutes the real pleasures of life:

"Pleasant it is, too, to find one whose admiration of nature and detail is heightened, not chilled, by the necessary 'investigation'—which in my humble opinion is one of the most useful as well as pleasing exercises of the intellect, in the circle of human study. How many are there who are delighted with a 'fine view,' but who seldom care to think of the mighty and mysterious agency that reared the hills, of the wonderful structure and growth of the forests that crown them, or of the complicated mechanism of the myriads of higher organisms that abound everywhere; who would see but little interesting in a fungus, and who would shrink with affected horror from a defenseless toad* * * Dr. Leidy is getting up a great work on comparative anatomy which is to be the modern standard. Such a work will be very useful to those who want to go to the bottom of natural history; it is an interesting study, too, to notice the modifications in form—the degradations,† substitutions, etc., among the internal organs and bones. The structure, forms and positions of teeth, too, are interesting to notice—so invariably are they the index of the economy and the position in nature of the animal."

This is the reflection of a lad of nineteen, an age at which some modern educators would have us believe our young men are just ready for the collegiate Freshman class.

*This passage probably indicates that he was sensitive to being teased about his interest in these animals.

†A word used by French writers of the time to express lines of descent.

During the same year young Cope went to Washington to study and work in the Smithsonian Institution under Spencer F. Baird, and it is amusing to observe him in the above letter classing himself with Baird as the only Americans who knew anything of the Batrachia. Upon April 19, 1859, he contributed his first paper (alluded to above) to the Academy 'on the primary divisions of the Salamandridæ, with a description of two new species.' He followed this by a full description in the same year of reptiles brought from West Africa by Du Chaillu, naming several new forms; also by a catalogue of the venomous snakes in the museum. In the succeeding three years he made twenty-four communications upon the Reptilia and established himself at the age of twenty-two as one of the leading herpetologists of the country.

It is obvious from other portions of the letter that by this time young Cope's career was fully determined in his own mind. Here and in the papers he was now presenting he shows keen observation and powers of systematic diagnosis, a wide range of self-acquired knowledge, and familiarity with the characteristics of his distinguished seniors, Agassiz and Leidy. This period included a year's study (1858–9) of anatomy and clinical instruction at the University of Pennsylvania. In 1863 he traveled abroad for several months, visiting especially the museums of Leyden, Vienna and Berlin and extending his horizon as a comparative anatomist, for upon his return he at once showed the impulse of the philosophical spirit, complete familiarity with the history of opinion and marked power of generalization. Thus his papers, which began to crowd the pages of the 'Proceedings of the Academy,' chiefly in recent herpetology and ichthyology, display a new breadth and range as in his division of the Anura into the *Arcifera* and *Raniformes* (Firmisternia) and his demonstra-

tion of the main evolution principles in these groups.

In 1865 he married Miss Annie Pim, daughter of Richard Pim, of Chester Co., Pa. In the year 1864 Haverford College called him to a professorship of natural science. This position, however, he held for only three years. Twenty-two years later he again resumed teaching as professor of geology and paleontology in the University of Pennsylvania, all the interval having been devoted to exploration and research. In 1865 he first began to extend his studies among the mammalia, especially the Cetacea, recent and extinct, of the Coastal Tertiary. Early in 1866 a wider paleontological field opened in the vertebrata of the Cretaceous marls of New Jersey, whence he procured the remains of Dinosaurs, describing especially the carnivorous *Lælaps*, and grouping (Nov., 1866), these reptiles into three great suborders, *Orthopoda* (Hadrosaurus and Iguanodon), *Goniopoda* and *Symphopoda* (Megalosaurus, Lælaps and Compsognathus). In the same year appeared the continuation of his tropical American and Sonoran herpetology and his third contribution to the history of the Cetacea. Henceforward his papers become far too numerous to consider together and we must endeavor to follow merely the main outlines of his life work.

This was a bright era in the history of the Academy, Leidy, Gill and Harrison Allen being frequent contributors. In 1868 Cope gave his first complete synopsis of the extinct Amphibia of the world. Between 1868 and 1870 he made his first six contributions upon the Plesiosaurs of the Cretaceous of Kansas and in 1871 began his first western explorations in these beds. This led to his connection with the U. S. Geological Survey, under Dr. Hayden, and to further explorations in Wyoming (1872) and Colorado (1873), which resulted in the discovery of many new types of fishes, mosasaurs, chelonians, dinosaurs and other reptiles, notably *Portheus*, *Platecarpus*, *Clidastes*, *Compsemys* (type of the Amphichelydia, Lydekker), *Protostega*, and *Agathaumus*. These were described chiefly in the Bulletins of the Survey and in the Transactions of the American Philosophical Society, and culminated in his first large volume 'The Vertebrata of the Cretaceous Formations of the West,' No. II., of the Hayden quartos, published in 1875.

He spent his summers in the Bad Lands, exploring the Bridger and Washakie, Wasatch, New Mexican and Judith River (1877 formations). The latter exposures he visited in 1874, in connection with the Wheeler Survey, securing a collection which is now preserved in the National Museum, and publishing a most vivid description of the geology of this interesting region. His movements in the field are described by one who was with him as so rapid and full of energy, so regardless of food and rest, that he wore out the other members of his parties and did not allow time for thorough search; yet he himself found a number of his most important types.

The fruits of the New Mexican journey appeared in many bulletins and were finally collected in his second great volume, 'The Extinct Vertebrata obtained in New Mexico by Parties of the Expedition of 1874,' Vol. IV., of the Wheeler Survey. In 1874 appeared the first of his studies upon the comparison of American and European horizons, and of his contributions to the John Day fauna. His collections were now accumulating so rapidly as to demand more time for research and for many years he was fortunate in securing the field services of C. H. Sternberg and Dr. J. L. Wortman. He continued to make brief expeditions, among the last being his trip into the Laramie region.

As early as 1868 it may be said that he had laid the foundations for five great lines

of research, which he pursued concurrently to the end of his life; these must, however, be followed separately to be understood and appreciated. Only for comparatively brief intervals would one line be pursued exclusively in order to complete some special memoir, for his marvelous memory apparently held and resumed the details of all the others with perfect ease.

FISHES.

Cope's work in ichthyology would alone have given him high rank among zoologists. In his early papers (1864) he appears as an enthusiastic systematist, studying especially the living forms of Teleosts, making careful diagnoses of all types that came into his hands, critically considering the problems of distribution, never casting aside those types whose especial difficulties had been the stumbling block of earlier writers. Thus he studied successively the fishes of Michigan (1864–65), of Virginia (1868), of the Lesser Antilles (1870), the cyprinids of Pennsylvania (1867), again the fishes of South Carolina (1871), of Alaska (1872), of Montana, those from South America collected by Professor Orton (1872–78), those from the territories collected by the Wheeler Survey, and even not infrequently new forms from Africa and the East Indies.

Almost from the first he set aside the superficial characters which had been employed in the classification of fishes, sympathizing keenly with the morphological spirit in systematic study which Dr. Gill was then showing. A great step in his career was, therefore, his purchase, while abroad, of Professor Hyrtl's private collection of fish skeletons, which gave him nearly a thousand admirable preparations for immediate study. Owen had proposed (1866) the Teleostomi to include the old Ganoids and Teleosts. Before the American Philosophical Society, in 1870, and the American Association, in 1871, Cope demonstrated the law that the primary divisions of the Teleostomi are indicated by their *fin structure*. This is now the accepted basis of sub-ordinal classification. Besides proposing the *Actinopteryii*, he established the fundamental division (Holocephali, Selachii, Dipnoi, Crossopterygii, Actinopterygii) of the living fishes into five groups, as they stand at the present day, upon cranial and fin structure. In 1876 Huxley adopted Cope's wide separation of the Holocephali from the Selachii. Fin structure as a taxonomic motive was uppermost in his mind and undoubtedly served to direct his attention later to the foot structure of land vertebrates as of diagnostic value.

The masterly part Cope continued to play in the major classification of the fishes may be gathered from a perusal of the introductions of Smith Woodward's standard volumes 'Catalogue of Fossil Fishes of the British Museum.' In 1884 he proposed a new Elasmobranch subclass, *Ichthyotomi*, from the Permian *Diplodus*. This order was subsequently enriched by his discovery of *Didymodus* and is now firmly established to include the pleuracanth and other paleozoic sharks. In 1889 he proposed another great sub-order, the *Ostracodermi*, which is also established.

His interest in the phylogeny of the group was naturally intensified by increasing knowledge of extinct forms, and here his wide studies among living types stood him in good stead, for he was first brought in contact with fishes from the Tertiary and Cretaceous, from the vertebrate remains from the New Jersey Greensand (1869) to the rich yields of the Green river shales (1871–7). The older fishes had long been in the hands of Professor Newberry, the pioneer among the fossil fishes of North America, but his studies came naturally to lead him among the more ancient types in his eager study of phylogeny. Into this difficult field he carried his work always with

suggestive results; for the most abstruse problems he had ever at hand a wide range of answers. Thus the curious fish-like *Bothriolepis* he compared to an armored ascidian, basing this surprising view upon a remarkable similarity in the arrangement of plates, arguing that it was reasonable to expect in the early horizon of *Bothriolepis* that the back-boned creature should be built on the plan of the ascidian tadpole. His final opinions and additions to the taxonomy and phyogeny of the fishes are inserted in the syllabus of his university lectures (1897).

AMPHIBIANS.

"There never has been a naturalist," writes Dr. Baur, "who has published so many papers upon the taxonomy, morphology and paleontology of the Amphibia and Reptilia as Professor Cope." The first of a series of more than forty papers upon the former group is the one 'On the Primary Divisions of the Salamandridæ, with descriptions of two new species,' alluded to in his letter above, and presented at the age of 19 (April, 1859). It exhibited the precocious taxonomic instinct which soon afterwards prompted him to attack and rearrange the major divisions of the Amphibia. Rapidly following this first essay by others upon the Anura, in 1865 and 1866 he outlined the larger Ecaudate or Anurous divisions: I. Aglossa; II. Bufoniformia; III. Arcifera; IV. Raniformia. At the age of 25 he described his first extinct Amphibian, *Amphibamus*, from the Carboniferous of Ohio, and at 28 he published his first large quarto memoir, 'Synopsis of the Extinct Batrachia, Reptilia and Aves of North America.'* This contained, in addition to the above, the recent urodelous divisions, Trachystomata, Gymnophidia, Proteida, but of chief importance, to include the Permian and Triassic forms of the world, he proposed the great extinct order *Stegocephali*, which has since been universally adopted. As a supplement to this memoir appeared in 1874 his 'Catalogue of the Air-Breathing Vertebrata from the Coal Measures of Ohio,' including results also published in the paleontology of the Geological Survey of Ohio of the same year. His researches and collections in the typical coal measures and Permian extended to Iowa and Illinois, leading to the determination of *Cricotus*, which in 1880* he made the type of the suborder *Embolomeri*, or Stegocephalia with double vertebral rings. In 1877 he received the first remains of *Eryops* and *Trimerorachis*, from the supposed Triassic, but actually Permian beds of Texas, animals which in 1882 he made the type of the *Rachitomi*, a second suborder of Stegocephalia. This accession of material, as we have seen, ranks with that of the Puerco among the chief events of Cope's scientific career, for the Permian of Texas yielded to him not only these remarkable Batrachians with complex vertebræ, but also the great primitive representatives of the Reptilia. The suborders Rachitomi and Embolomeri have been grouped as Temnospondyli in contrast with the specialized Labyrinthodontia and simpler Microsauria of Europe, chiefly made known through the labors of Fritsch, Credner, Gaudry and Miall. Cope's brief memoir of 1884 upon the 'Batrachia of the Permian Period of North America' summed up his previous contributions, but he anticipated that the more exhaustive monographic treatment of the rich amphibian and reptilian fauna of this period, exclusively collected and described by him, would constitute a volume of the Hayden Survey memoirs and give him an opportunity of rounding up his prolonged studies.

In the meantime his investigations upon the living Batrachia extended to Central and South American species, as well as to very original observations upon the laws of

* Trans. Amer. Phil. Soc., read 1868, pub. 1869. See also Proc. Phil. Acad. Nat. Sci., 1868, p. 211.

* *American Naturalist*, p. 610.

geographical distribution of the Amphibia, which were published by the Smithsonian Institution. In 1875 he prepared a 'Check List of the North American Batrachia and Reptilia' for the U. S. National Museum; this was followed by an essay 'On the Zoological Position of Texas' (1880). Soon afterwards, at the request of Spencer F. Baird, he began the preparation of a general work upon the Batrachia; this was facilitated by a manuscript prepared for a work of the same character both by Baird and Girard, but was not completed until 1889. As a volume of 523 pages and numerous plates this work,* while showing many signs of haste and subject to considerable changes in the larger systematic divisions, fortunately remains as a monument of the immense range of knowledge and observation of its author upon the structure and habits of the living representatives of this group. It must always be a matter of regret that he could not have published his final views upon the extinct forms. One of his most most important generalizations from the latter, contained in a short memoir, 'The Intercentrum of the Terrestrial Vertebrata' (1881), is that the vertebræ of living amphibia are composed of intercentra and are, therefore, not homologous with the true centra (pleurocentra) of reptiles, birds and mammals.

REPTILES.

We have already traced Cope's initial work upon the Reptilia. As in other groups, his researches rapidly branched out in many directions, first his treatment of the reptiles of the Bridger and other freshwater Tertiary lakes in connection with the mammalain fauna; second, the continuation of his systematic description of the Kansas Cretaceous fauna; third, the brief papers upon the herbivorous Dinosaurs of the Dakota (1877 and 1878) and the horned Dinosaurs (*Monoclonius*) of the Laramie formations; fourth, the numerous papers upon the Reptilia of the Triassic and especially of the Permian. The latter must be considered the most important and unique in their influence upon paleontology. In 1875 he first announced the discovery of reptiles in the Permian, and in 1877 he reported the first primitive Crocodilia (*Belodon*) and Dinosauria (*Clepsysaurus* and *Zatomus* in the Triassic of North Carolina.

The detailed sequence of this reptilian work is clearly stated by Professor Baur: "Already in 1864 he published a paper on the characters of the higher groups of the Squamata.* Two years later he made his first remarks about the Dinosaur *Lælaps*,† and in 1867 he compared the carnivorous Dinosaurs with the birds;‡ this he did before Huxley's paper upon the same subject appeared.§

In 1870 he read an important paper before the American Association 'On the homologies of some of the Cranial Bones of the Reptilia and the systematic arrangement of the class.'‖ He discussed the following topics.: 1. Homologies and Composition of the cranial arches. 2. The cranium of the Ichthyosauria. 3. The cranium of the Anomodontia. 4. The homologies of the opisthotic. 5. The squamosal bone. 6. The columella (epipterygoid.) 7. The systematic arrangement of the Reptilia. 8. Critical remarks on the system. 9. The Rhyncocephalia and supposed Lacertilia of the Trias and Permian. 10. Stratigraphic relation of the orders of Reptilia.

His classification is this:

A. Extremities beyond proximal segment not differentiated as to form.

I. *Ichthyopterygia:* Order *Ichthyopterygia.*

* 'The Batrachia of North America.' Bull. No. 34, U. S. Nat. Museum.

* Proc. Acad. Phila., 1864, p. 224.

† *Lælaps aquilunguis*, Cope. Proc. Acad. Nat. Sci., Phila., July, 1886, p. 275-279.

‡ Ibid., 1867, p. 234-235.

§ *Popular Science Review*, 1868, p. 237-247.

‖ Proc. Assoc. Adv. Sci., XIX., p. 194-247.

B. Extremities differentiated.

II. *Streptostylica*: Orders *Lacertilia, Pythonomorpha, Ophidia.*

III. *Synaptosauria:* Orders *Rhyncocephalia, Testudinata, Sauropterygia.*

IV. *Archosauria:* Orders *Anomodontia, Dinosauria, Crocodilia, Ornithosauria.*

In 1875 the large volume 'The Vertebrata of the Cretaceous Formations of the West' appeared, as Vol. II., of the Rep. U. S. Geol. Surv. Territ. (302 pp., Pl. LVII.). This work contains extensive descriptions, especially of the Mosasaurs, also of Testudines, Crocodilia, Plesiosaurs and Dinosaurs (Iguanodontia): *Agathaumus*, Cope (*Triceratops*, Marsh(; *Hadrosaurus*, Leidy (*Trachodon*, Leidy; *Diclonius*, Cope, *Claosaurus*, Marsh).

Cope's most epoch-making contributions, however, are his researches on the Permian Reptiles of Texas, which commenced in 1878. In the Proceedings of the American Philosophical Society of this year he established the sub-order *Pelycosauria* of the *Rhynchocephalia* to contain *Clepsydrops, Dimetrodon, Diadectes, Bolosaurus, Pariotichus, Empedias.* In the December *Naturalist* of the same year the order *Theromorpha* was created, with the sub-orders *Anomodontia*, Owen, and *Pelycosauria*, Cope. The *Pelycosauria* were considered as the ancestors of the *Mammalia.* In 1880* a new division of the Theromorpha was established, with the name of *Cotylosauria*, to contain the family *Diadectidæ.* In a skull of *Empedias* he described two occipital condyles, being misled by the missing basioccipital. In 1883† he placed his genera *Pariotichus* and *Pantylus* in a new family *Pariotichidæ*; characterized by the over-roofing of the temporal fossæ and the presence of the supra-occipital and par-occipital plates (intercalare, Cope). He now found the basi-occipital in position and the *Cotylosauria* were given up. In 1890 (March 12th) Cope placed again the *Cotylosauria* as a sub-order with the Theromora distinguishing three families: Pareiasauridæ, Pariotichidæ, Diadectidæ. In 1882* Seeley had established the order *Pareiasauria*; Lydekker (1889) and Zittel considering it a sub-order of the Theromora. In 1892† the Cotylosauria were made an order by Cope. The two last papers published by Cope in the Proceedings of the American Philosophical Society give much new evidence about this very interesting group. The titles of these papers are: 'The Reptilian Order Cotylosauria'‡ and 'Second Contribution to the History of the Cotylosauria.'§ In this paper a new family, *Otocœlidæ*, was described with the following characters: Posterior border of temporal roof excavated laterally by the meatus auditorius externus. Teeth present in a single row, not transversely expanded. Ribs immediately overlaid by parallel transverse derm-ossifications which form a carapace. This family he considered, or at least suggested was, ancestral to the Chelonians.

Cope had in preparation for many years an extensive work on the *Lacertilia* and *Ophidia* of the United States, to be published, like his *Batrachia*, in a bulletin of the United States National Museum.‖ The

* *American Naturalist*, p. 304.

† Proc. Amer. Philos. Soc., p. 631.

* Proc. Roy. Soc., Vol. 44, p. 383.

† Trans. Am. Phil. Soc., Vol. XVII.

‡ Proc. Am. Philos. Soc., Vol. XXXIV., 1896 (Feb. 2d), p. 436–457, Pl. VII.–IX.

§ Ibid., Vol. XXXV., p. 112–139, Pl. VII.–X. Aug. 15, 1896.

‖ Many preliminary papers have appeared for this publication, of which the following are named below:

'An Analytical Table of the Genera of Snakes.' Proc. Am. Philos. Soc., 1886, p. 479–499.

'The Osteology of the Lacertilia.' Proc. Am. Philos. Soc., Vol. XXX., 1892, p. 185–221. Pl. II.–VI.

'On Degenerate Types of Scapular and Pelvic Arches in the Lacertilia.' Journ. Morphol. Vol. VII., 1892, p. 233–244, Pl. XIII.

'The Classification of the Ophidia.' Trans. Amer. Philos. Soc., Vol. XVIII., April 15, 1895, p. 186–219, Pl. XIV.–XXXIII.

'On the Hemipenes of the Sauria.' Proc. Acad. Nat. Sci. Phila., August, 1896, p. 461–467.

MSS. for this work cost him much labor, especially during the past two years, and for a while interrupted all his other work. It was characteristic of him to turn aside for a laborious detailed investigation of the soft anatomy of the snakes in the hopes of finding some satisfactory means of classifying this puzzling group. This investigation constituted his latest original work and was barely completed before his death.

MAMMALIA.

Up to 1868 Leidy held the Western paleontological field exclusively. In this year Marsh and Cope also entered the Western territory and began the simultaneous exploration and description of a limited fauna in a somewhat limited region, with the inevitable result of a struggle for priority and a permanent rupture of friendly intercourse. It is necessary to allude to the fact, because it greatly affected the subsequent history of American paleontology. Fortunately, the western fossil area proved to be a vast one, and the remarkable discoveries by Wortman in the Big Horn and Wasatch, beginning in 1878, also by Baldwin in the Puerco of New Mexico, beginning in 1880, and the explorations already described of Cummins in the Permian of Texas, afforded Cope a noble field of research quite free from the haste of rivalry. From the Wasatch ungulates Cope established the stem forms of three lines of Perissodactyla and of far wider import than these, the foundations of the classification of the great group of Ungulata. The generalized *Phenacodus*, which he at first regarded as a perissodactyl, furnished the key to the evolution of the carpus and tarsus, from the serial (Taxeopod) to the displaced (Amblypod and Diplarthrous) types with the interlocking joints. Kowalevsky, in 1873, had pointed out the significant articulations of the metapodials; Cope now showed the still greater importance of the mutual articulations of the podials, firmly establishing thereupon the orders *Condylarthra* and *Amblypoda*, uniting Owen's Perissodactyla and Artiodactyla into the *Diplarthra*, and by hypothetical phyla connecting the Proboscidia and Hyracoidea with a still-to-be-discovered plantigrade, unguiculate, bunodont stem, the 'protungulate' of Huxley and Kowalevsky. These generalizations, despite errors of excess and of detail which Rütimeyer and Osborn have pointed out, constituted the first distinct advance in mammalian classification since Owen demolished Cuvier's 'pachydermata;' they rank with Huxley's best work among similar problems, and afford a basis for the phylogenetic arrangement of the hoofed orders which has been adopted by all American and foreign paleontologists.

At the same time it became apparent that the hoofed mammals had sprung from clawed ancestors, but the Wasatch period was too remote from the parting to furnish conclusive evidence. This evidence came in a flood from the underlying Puerco fauna, the systematic treatment of which constitutes the most unique section of Cope's work among the extinct mammalia. From this material originated his second great generalization—namely, that the primitive pattern of the molar tooth consists of three tubercles. Around this *trituberculy* centers the whole modern morphology of the teeth of the mammalia and the establishment of a series of homologies in the teeth of most diverse types, wholly unsuspected in the 'Odontologies' of Cuvier and Owen, connecting the most ancient Mesozoic mammals with the most modern and specialized types, including the teeth of man. The force and application of the tritubercular law Cope clearly perceived, but left to others to fully work out and demonstrate. It promises ultimately to give us the key to the entire phylogeny of the mammalia, extending to every division of the Marsupialia

and Placentalia, and will probably be found among the Monotremata.

These are the mountain peaks, the points where exploration and discovery were followed by happy inspiration, in a chain of contributions, which includes his exposition of the faunal succession from the base to the summit of the tertiary. In the Bridger, Cope himself found the lower jaw of *Anatomorphus*, with its typically human dentition, which, owing to its extreme antiquity, occasioned him a greater surprise than any discovery he ever made; he also found the last of the great race of Uintatheres at the top of Washakie Mountain. We owe to him alone our knowledge of the scanty Wind River fauna. From the White River Oligocene his materials were poor and his work less satisfactory. From the rich Upper Oligocene, with the assistance of Wortman, he secured fine collections and has especially enriched our knowledge of the *Anchitheriidæ*, *Felidæ* and *Canidæ*. From the Upper Miocene Deep River and Loup Fork beds he has practically contributed all that we know, especially of the Rhinoceroses, Horses, Mastodons, Camels and other ruminants and carnivora. Of the latter fauna his most complete papers were upon the evolution of the *Oreodontidæ*. His latest contributions to our knowledge of the fossil mammalia were upon the fauna of the Blanco and Palo-Duro, or Goodnight beds of Texas and the rich cave fauna from Port Kennedy, Pa., brought together by Dr. H. C. Mercer. It was his intention to cover the entire later Tertiary in a second part of the 'Tertiary Vertebrata;' many of the plates and much of the MSS. of this volume are ready.

The 'Tertiary Vertebrata,' Vol. III., of the Hayden quartos published in 1883, is his most imposing contribution to paleontology, including his studies of all the vertebrate fauna of the Tertiary lakes west of the Rockies. This work of over a thousand pages and eighty plates is said to have been the despair of the public printer owing to the constant additions made while in press. It extends from the Puerco to a portion of the Lower Miocene fauna. Besides the full description and illustration of the great hoofed orders above alluded to, it contains the full exposition of the characteristic forms of *Creodonta*, an order of primitive carnivora which he separated from the Marsupiala in 1875, and in which he placed six families of mammals from different parts of the world.

Before leaving the mammals it is fitting to speak of his work upon 'kinetogensis,' or the mechanical origin of the hard parts of the body, especially of the teeth, vertebræ and limbs. An invaluable paper by his friend and later colleague, Ryder, put him upon this line of investigation, the results of which he published in a long series of papers culminating in his memoir upon the 'Origin of the Hard Parts of the Mammalia' and in his collections of essays in the 'Origin of the Fittest' and 'Primary Factors of Organic Evolution.' One of his chief motives in these researches was the demonstration, he believed they afforded, of the hereditary transmission of the effects of individual efforts, use and disuse, but even if this motive is subsequently shown to be an illusive one, by our future knowledge of the real nature of evolution, these investigations lose little, if any, of their intrinsic value. First, as in all his work, he brings together an immense array of valuable facts and observations; second, he extends the principle of the independent origin of similar structures; third, he in most cases successfully establishes the actual mechanical adaptive or teleological relations of the parts described; fourth, he traces the course of phylogenic modification in a number of important organs and thus establishes certain obscure homologies, notably

those in the teeth of the Amblypoda, Coryphodon and Uintatherium.

PHILOSOPHY.

Cope's contributions to philosophy began in 1868, with the remarkable essay upon the "Origin of Genera,' and, continuing steadily in a series of papers which in collected form fill three octavo volumes, they cover both the data and the factors of evolution, psychology, ethics and metaphysics. Unpublished manuscripts, prepared in connection with his last work, 'The Primary Factors of Organic Evolution,' contain also his views upon many sociological and theological problems. It is singular that at the age of 28 he adopted the Lamarckian theory under cover of a misconception of a part of Darwin's theory, for he states the *latter* in part as follows: "This is, in brief, that the will of the animal, applied to its body, in the search for the means of subsistence and protection from injuries, gradually produces those features which are evidently adaptive in their nature." He soon detected this error; but a year later, in a paper upon 'The Laws of Organic Development,' before the American Association, he again connected rudimentary will or consciousness with use and effort, and struck the keynote of all his later evolution philosophy in the sentence: "Thus intelligent choice may be regarded as the originator of the fittest, while natural selection is the tribunal to which all the results of accelerated growth are submitted." (1869.)

His chief contention in the 'Origin of Genera' is that, while a large proportion of specific characters are adaptive, few generic characters are so, and the latter evolve separately by the force of 'acceleration or retardation' of one of several plans or types of development preordained by the Creator. To sustain this proposition he applied the principles of arrested, hastened or abbreviated development with extraordinary knowledge both of the osteology and soft anatomy of the entire vertebrata to hundreds of examples of *exact* and *inexact parallelism*,* and with such force that he completely establishes his law. Incidentally the principle of *heterology*, or what Lankester has since termed homoplasy, is abundantly illustrated. Darwin, in one of his letters, states that he never could understand this Cope-Hyatt† law of 'acceleration and retardation.' It is undeniable that its exposition might have been clearer; of its truth, not as a theoretical factor, but as a grand principle of evolution, there can, however, be no question, and it has received far less attention than it deserves.

Cope subsequently altered some of the main standpoints of this thesis, but his systematic definition of genera and families, horizontally or transversely to phyletic descent according to the heterologous assumption of similar structures, persisted as a conspicuous and confusing feature of all his later phylogenetic tables and writings. It is throughout evident that in 1868 he was still *en route* to his later broader conception of the sweeping extent and natural causation of evolution. He entered vigorously into the evolution compaign,‡ always showing great consideration and courtesy for his orthodox opponents and desiring rather to convert than to offend. As above noted, in 1870, he drew a sharp distinction between the 'preservation of the fittest' and 'the causes of the origin of the fittest,' which he ascribed to the increase and location of 'growth force.' In 1871 appeared 'The Method of Creation of Organic

* Parallelism is here used in the sense of recapitulation (von Baer), not of homoplasy or convergence.

† Professor Hyatt, Cope's fellow laborer in Lamarckism, worked out this law independently at the same time.

‡ 'On the Hypothesis of Evolution,' *Lippincott's Magazine*, 1870; 'Evolution and its Consequences,' *The Penn Monthly*, 1872.

Forms,'* in which he set forth in a most interesting way a complete system of the modes and causes of evolution under the five laws of: (1) Acceleration and Retardation; (2) Repetitive Addition; (3) Use and Effort; (4) Bathism or Growth Force; (5) Intelligent Selection. This system was largely original with him, because he had not as yet studied Lamarck's writings, knowing them only through abstracts; it cannot be said, however, that he ever either advanced beyond or substantially modified the theoretical position he reached at the age of 31. Later, as he carefully studied the writings of the great French naturalist, he fully recognized Lamarck's priority and accepted the Neo-Lamarckian title when it was applied to him during the Weismann controversy. Cope, Hyatt, Ryder and Packard became the pioneers of the school in America. It is not necessary here to detail his widely known arguments as champion of this philosophy, which he gathered from his rich stores of comparative anatomy and paleontology and put forth in numerous essays and public discussions, concluding with his final argument before the recent meeting of the American Society of Naturalists, in Boston.† Suffice it to say that he showed much of the same kind of confident strength and of the same logical weakness which characterized Lamarck. The latter, in fact, among all naturalist philosophers is Cope's nearest prototype. The papers upon the 'Origin of Intelligence' (1872), 'Consciousness in Evolution' (1874), 'The Origin of the Will' (1877), 'On Archæsthetism' (1882), follow a line of thought largely foreshadowed by Lamarck, but none the less striking. Cope was nothing daunted by Weismann's challenge and vigorous attack upon the transmission theory, and maintained to the end that the paleontological evidence was too strong to be refuted. His first collected essays, 'The Origin of the Fittest,'* antedated this discussion, but his second collection, 'The Primary Factors of Organic Evolution,'† enters into it very fully and with as much force of reason as the facts afford at present. This volume goes over some familiar territory, yet is striking because of the very wide range of fresh reading and research it gives evidence of. The concluding chapter contains (p. 508) his final statement of what may be called his fundamental causal principle—namely, the formative or creative rôle of consciousness from the dawn of life.

Side by side with these studies of the factors of evolution are numerous essays upon the history of man,‡ beginning in 1875, and upon the evolution of the vertebrata, progressive and retrogressive, which are full of speculative phylogeny. In formulating descent trees Cope has been second only to Haeckel. He let no opportunity slip by of at least throwing out an hypothesis as to the phyletic relations of every great type he studied, and many of these random guesses have been confirmed.

More remote from the main trend of his profession were his collateral intellectual pursuits, each of which seemed to issue from a clearly defined alcove of his brain upon consecutive occasions and express his ever widening and deepening philosophy. His progressive thought upon metaphysical problems can be followed in 'The Origin of the Will' (1877), 'Theology of Evolution' (1877), 'The Relation of Mind to Matter' (1877), 'Ethical Evolution' (1889),' An Outline of the Philosophy of Evolution' (1889), 'The Evolution of Mind' (1890), 'The Foundations of Theism' (1893).

*American Philosophical Society, December 15, 1871.

† Reported in SCIENCE, April 23, 1897.

* D. Appleton & Co., 1897, 8vo., 467 pp.

† Open Court Publishing Co., 1896, 547 pp.

‡ Among others see 'The Genealogy of Man,' *American Naturalist*, 1893; 'Lenurine Reversion in Human Dentition,' *Journal of Morphology*.

In this review no mention has been made of Cope's several papers upon fossil birds or of his extremely valuable contributions to historical geology.

We have at present few data for the history of his later life apart from that furnished by his writings. His editorial connection with the *American Naturalist*, begun in 1878, in association with Professor A. S. Packard, who retired a few years later, was continued for twenty years, with a great sacrifice of time. It afforded an outlet for his continuous stream of shorter publications and for the free expression of his very independent opinions upon current scientific movements and topics. This constant occupation kept him from foreign travel; at the time of the first Paris Exposition he made his second and final journey abroad. He was a close student but never a recluse. Extremely fond of the society of thinking people, he was also a very regular attendant upon the learned societies of his city and country. It is a cause for regret, and an instance of the non-recognition of genius, that only at a very late day the Society of Naturalists and the American Association for the Advancement of Science elected him to their chief offices. His retiring presidential address was to have been made at the coming meeting of the Association.

The most conspicuous feature of Cope's personal character from boyhood upwards was his independence; this was partly the secret of his venturesome and successful assaults upon all traditional but defective systems of classification. He was no respector of authority *per se*. Even if sometimes mistaken his fearless criticism of men and of institutions was chiefly animated by high ideals, not by personal feeling, nor for personal advantage. His open and aggressive statements made him many opponents and attracted to him many friends, because whether right or wrong they always sprang from conviction. Another marked characteristic was his fortitude. He bore material reverses with stoical resignation, regretting chiefly the limitations they placed upon his explorations. He was full of cheer and determination when things looked most unpromising, allowing nothing to disturb the composure which is so essential to research. His life in fact became a fine illustration of the happiness attendant upon plain living and high investigation which he foresaw at nineteen in his letter to his cousin quoted above.

Cope is not to be thought of merely as a specialist in paleontology. After Huxley he was the last representative of the old broad-gauge school of anatomists and he is only to be compared with members of that school. His life-work bears the marks of great genius, of solid and accurate observation and at times of inaccuracy due to bad logic or haste and overpressure of work. The greater number of his Natural Orders and Natural Laws will remain as permanent landmarks in our science. As a comparative anatomist he ranks both in the range and effectiveness of his knowledge and his ideas with Cuvier and Owen. When we consider the short life of some of the favorite generalizations of these great men he may well prove to be their superior as a philosophical anatomist. His work, while inferior in style of presentation, has another quality which distinguished that of Huxley—namely, its clear and immediate perception of the most essential or distinctive feature in a group of animals. As a natural philosopher, while far less logical than Huxley. he was more creative and constructive, his metaphysics ending in theism rather than agnosticism. In mere mass of production Cope's work was extraordinary. He leaves twenty octavo and three great quarto volumes of collected researches. By his untimely death a wide gap is left which can never be filled by one man.

HENRY F. OSBORN.

COLUMBIA UNIVERSITY, May 3, 1897.

*PSYCHOLOGY AND COMPARATIVE PSYCHOLOGY.**

It is now more than ten years since I suggested to a few of the students of this Faculty of Comparative Medicine that it might be interesting and profitable to band together for the study of the psychic nature of animals, particularly those animals with which we are brought into daily contact.

In December, 1885, at a meeting called to consider the subject, it was unanimously decided that a society should be formed to study animal intelligence as best it could. Practically all the students and those teachers more immediately connected with the work of this Faculty joined the Association and entered into the new project with enthusiasm. It was early decided that only material obtained either at first hand or from the most reliable sources should be brought before the Association, and that principle, the wisdom of which will not be questioned, has been acted upon throughout.

Whatever the value of the papers and discussions which have engaged our attention it may be fairly claimed that the facts upon which they have been based were beyond question. The first essential in any student of nature is a strong desire to know the truth, and, therefore, a great respect for exact observation at the outset. While theories change, and this is inevitable owing to the imperfection of our grasp of many-sided truth, a fact is always a fact. The patient collection of facts, so well illustrated by the illustrious Darwin, when theorizing without very great regard to them was so tempting in framing explanations of organic nature, is a work that the world long undervalued and the importance of which it is to be feared all psychologists at the present day do not adequately appreciate.

* An address delivered to the Association for the study of Comparative Psychology in Montreal, November 2, 1896.

In this, at all events, our unpretentious Association may claim to have trodden in the safe path. At the end of our first decade of existence it may be profitable to review what has been accomplished. It could scarcely be expected that the members of this Association, being for the most part undergraduates, whose time is largely taken up with professional studies, should be able to make elaborate original researches worthy of publication. From the first, however, our proceedings have been given to the public in condensed form by the local press, and evidence has been abundant on every hand that one of the results has been an altered attitude of mind on the part of many intelligent persons in this city towards the animal world about us, notably our domestic species. This is not a work to be despised, for the welfare of our fellow creatures lower in the scale is largely dependent on the views we entertain of their psychic nature.

It is surely not to be supposed that such studies as have engaged the members of our Association are without a value of a professional kind; for in the handling of sick animals, in diagnosing their exact condition, in appreciating their sensations and generally in understanding their entire nature, the man who observes and reflects on such things must be more competent as a veterinarian, other things being equal, and certainly a more agreeable visitor to both patients and clients.

But it is difficult, in my opinion, to overestimate the good to the individual who in the right spirit studies animals. A frame of mind is established which, even when one exaggerates animal intelligence, is rarely practically harmful—often the reverse—and nearly always begets sympathy and modesty.

Psychology has passed through great changes, during even the last decade. Now almost every college in America of much

importance has its chair of psychology, and many colleges are provided with psychophysical laboratories. In America alone there are two periodicals devoted to this subject; and at last pedagogical institutions are attempting to found the training for teachers on the laws of the mind, *i. e.*, on psychology. In fact no recent educational movement has been more widespread in its influence or more rapid in its development than the modern psychology.

The scope and methods of the science have also changed. While none the less introspective, it has become more objective. The allied science of physiology owes something to psychologists, notably in the direction of a more complete and accurate study of the senses and keen criticism of positions assumed by physiologists in regard to the central nervous system.

The psychologists have borrowed freely from the realm of mental and nervous disease; all of which marks a new departure from which not only psychology, but physiology and practical and scientific medicine, must benefit.

It is usually a hopeful sign when methods of exact estimation begin to be applied to any science. There has been much diversity of opinion as to the extent to which this can be or has been successfully done in psychology. In the opinion of one of the most accomplished workers in this department of the science who occupied the presidential chair at the last meeting of the American Psychological Association, there can be no doubt about the value of such methods and their application. He says: "I venture to maintain that the introduction of experiment and measurement into psychology has added, directly and indirectly new subject-matter and methods, has set a higher standard of accuracy and objectivity, has made some part of the subject an applied science with useful applications, and has enlarged the field and improved the methods of teaching psychology."

But what shall we say of the *status* and prospects of comparative psychology? The works of Romanes were well known prior to the beginning of the last decade. They may be considered as marking about the first serious attempts to treat the subject of comparative psychology in a truly scientific spirit and in a form accessible to the intelligent portion of the general public.

Much later appeared the books of Professor Lloyd Morgan—works which possess the charm of unusual clearness. If Romanes was open to the charge of claiming too much for animals, Morgan is certainly cautious enough to please the most conservative, unless it be those who deny true intelligence to animals entirely.

It is a hopeful sign of the times in psychology that a professor of philosophy, Dr. Carl Groos, of Giessen, has found material for a book of considerable size on the play of animals, a subject which has been treated by him with interest, learning and critical acumen.

Animal intelligence is more and more attracting the attention of the professed psychologist and biologist, and that both realize the difficulties of the subject, while its importance is acknowledged, is of good omen. Comparative psychology is now beyond the stage of neglect and contempt, though there are those who seem to think that before we can judge of the mental processes of animals much greater progress must first be made in the study of the human mind; in other words, they would take their standards, their criteria from human psychology. That we must in the end find the clue to interpretation from ourselves there is no doubt. But is it not the fact that every complicated subject has been advanced by studies on a lower plane and by the process of comparison? Anatomy and mammalian embryology would

scarcely be worthy of the name of sciences to-day but for studies conducted on simpler forms. Do not psychologists sometimes forget, as anatomists long did, that the human is scarcely to be comprehended apart from the study of simpler creatures? Should we not look at psychology as the naturalist now does at zoology, and endeavor to discover the various grades in psychic processes, if such there be, and it is only, so far as I can see, by comparative investigation that their existence or non-existence can be established.

To do such work at its best requires a knowledge of both biology and psychology, and an intimate acquaintance with the ways of animals. Closet lucubrations can not be expected of themselves to advance comparative psychology very much.

Might not human psychology be made more objective still, and is not the amount of wheat garnered much out of proportion to the quantity of sheaves brought to the thresher? Has individual psychology received the attention it deserves? Might not the inductive method be more fully applied to psychology? I have long been convinced that differences for races and for individuals have been insufficiently recognized in physiology, and at last there seems to be a reaction against the former reckless leaps from frog or rabbit to man.

The physiologist cannot, however, afford to ignore the frog or the rabbit even when his goal is man; nor, if I may venture to express an opinion, can the psychologist do so either without some loss,—possibly great loss, to his subject.

I hope to see published in the next few years detailed studies on many individual human beings of both sexes and also on individual animals. We must have more facts for our conclusions. The departures of French psychologists are very welcome, whatever the final outcome may be. It cannot be doubted that the study of hypnotism, double personality and morbid states of various kinds has greatly advanced our knowledge of the normal man, and his fellows lower in the scale; and I should be disposed to say that the investigation of the psychic processes of animals aids in the comprehension of even such abnormal states as those to which reference has been made.

At the recent great Psychological Congress at Munich there was, among others, a department for comparative psychology; and an endowed lectureship on this subject has recently been established at Aberdeen, so that it is clear that in this, as in other directions, the world is moving.

If my view is correct that we are in need of vastly more facts and observations, then is there room for many workers. The experimental has a wide range of application in comparative psychology and as yet but little has been done. In this direction, as I have urged for years on our members, we could do much to advance the subject we have at heart.

It has been my happy privilege to attend every meeting of this Association held since its foundation, and reviewing the work of the past ten years I feel that, although it has been a humble one, the Society for the Study of Comparative Psychology in Montreal has not existed in vain.

Wesley Mills.

McGill University.

PAREIASAURIA SEELEY (COTYLOSAURIA COPE) FROM THE TRIASSIC OF GERMANY.

The first notice on *Triassic Pareiasauria* was published in 1857 by Professor Fischer, of Freiburg in Breisgau, based on notes received from the eminent paleontologist Hermann von Meyer, to whom he had sent the specimen for examination. The title of the paper is: *Über Sclerosaurus armatus* H. v. Meyer, eine neue Saurier-Gattung aus dem Bunten Sandstein bei Warmbach gegenüber Rheinfelden. Hierzu Tafel III

nach einer Photographie [und eine Figur, Wirbel und Rippen]. Neues Jahrb, f. Mineral., Geogn. Geol. und Petrefactenkunde, Jahrgang, 1857; Stuttgart, 1857, p. 136–140. Two years later H. v. Meyer gave an excellent description with a very good plate of this specimen in the Palaeontographica Bd. VII., 1. June, 1859, p. 35–40, Taf. VI. "*Sclerosaurus armatus* aus dem bunten Sandstein von Rheinfelden." This most interesting form has been entirely overlooked in all modern text-books and hand-books of paleontology and by all authors who have written about the *Pareiasauria.**

The specimen was found in the upper layers of the 'Bunte Sandstein,' near Ingerfelden, in Baden, n. w. of Rheinfelden, in Switzerland, with *Gyrolepis alberti*, Agassiz. The fossil consists of twelve consecutive presacral vertebræ, the ribs in connection, the pubis, the two femora, and the dermal armour.

The vertebræ, the rib-articulations, the pubis are typically Pareiasaurian. Of the greatest interest is the dorsal armour. There is a median series of rhombic plates, somewhat broader than long, the posterior end a little overlaped by the anterior end of the following plate. Each of these plates corresponds to a single vertebra. With the posterior sides of the plates of the median row, 2 or 3 more or less rhomboidal plates are connected, which cover the ribs. Therefore for each segment there are one median and 2 or 3 lateral dermal plates. Their connection is loose.

In *Pareiasaurus* Owen we have also a dorsal armour. Three rows of scutes extend down the median line of the back, and are partially in contact with the neural spines. The median row is placed on the summits of the neural spines. In connection with these, laterally, there is a pair of scutes extending transversely outwards (Seeley). In 1878 Wiedersheim* published a paper entitled *Labyrinthodon Rütimeyeri.* Ein Beitrag zur Anatomie von Gesammtskelet und Gehirn der triassischen Labyrinthodonten. Abhandlungen der schweizerischen palaeontol. Gesellsch., Vol. V. 1878, p. 1–56, Pl. I.—III.

The specimen on which the description is based was discovered in 1864 at Riehen (Switzerland), near Lörrach (Baden). The locality in which *Sclerosaurus* was discovered is only 11 kilometers distant from the locality in which Wiedersheim's '*Labyrinthodon*' was found. In both places *Gyrolepis Alberti* Agassiz occurs, and there is no doubt that these forms came from exactly the same horizon of the Upper Bunte Sandstein.

The specimen of *Labyrinthodon* is nearly complete, but some of the bones have been destroyed, leaving only the vacuities. This fossil is no *Labyrinthodont* at all, but a *Pareiasaurian* identical with *Sclerosaurus armatus* H. v. Meyer.

Already *Zittel*† has doubted its Stegocephalian nature, and stated that it probably belongs to the reptiles, giving several reasons for this opinion. The latest contribution is from *Seeley. On the complete skeleton of an Anomodont Reptile (Aristodesmus Rütimeyeri, Wiedersheim) from the Bunter Sandstone of Riehen, near Basel, giving new evidence of the relation of the Anomodontia to the Monotremata.*‡ Seeley has examined the specimen

*I may mention here that the same is true for *Pristerodon McKayi*, Huxley from the Permo-triassic of South Africa. T. H. Huxley. On *Saurosternon Bainii* and *Pristerodon McKayi*, two new fossil Lacertilian Reptiles from South Africa. Geol. Magaz. Vol. V. No. 5, May, 1868, p. 1–4, pl. XI. and XII.

*This paper is absolutely useless, full of mistakes and unsound ideas, indicating absolute inability to handle the material.

† Zittel, Karl A. Handbuch d. Palaeont. Palaeozool. III. Band., 1888, p. 407-408.

‡ Ann. Mag. Nat. Hist. (6) Vol. 17. Febr., 1896, p. 183-184. (From Proc. of the Royal Society.)

and reaches the following result: The reputed humerus is the interclavicle; the reputed scapula is the humerus; the reputed supra-scapula is the left coracoid; the reputed supra-scapula is the right scapula; the reputed right and left coracoids are the pre-coracoid (epicoracoid) and coracoid of the right side; the reputed clavicles are ribs. Five digits are identified in place of four. The fossil is referred to a new genus —*Aristodesmus*. It is identified as an Anomodont reptile, chiefly on the basis of resemblence to *Procolophon* and *Pareiasaurus*. He also compares it with the *Monotremata*. In conclusion, he argues that the points of structure are so few in which *Monotreme* mammals make a closer approximation to the higher mammals than is seen in his fossil (*Aristodesmus*) and other *Anomodontia*, that the *Monotreme* resemblances to fossil reptiles become increased in importance. He believes that a group *Theropsida* might be made to include *Monotremata* and *Anomodontia*, the principal differences (other than those of the skull) being that *Monotremes* preserve the marsupial bones, the atlas vertebra and certain cranial sutures. *Aristodesmus*, which suggests this link, is at present placed in the *Procolophonia*, a group separated from its recent association with *Pareiasaurus*, and restored to its original independence because it has two occipital condyles [!], with the occipital plate vertical, and without lateral vacuities, and has the shoulder-girdle distinct from *Pareiasauria* in the separate precoracoid extending in advance of the scapula. In the same remarkable communication Seeley discusses, also, the relation of the Labyrinthodont type to the existing Amphibia, and *regards the Labyrinthodont osteology as demonstrating closer relationship with Ichthyosauria and Anomodontia. The group is therefore regarded as reptilian, forming a branchiate division of the class* [!]. What are such wild speculations good for?

To conclude I give the synonyms of this reptile.*

Sclerosaurus armatus, H. v. Meyer. Neues Jahrbuch f. Min., 1857, p. 136.

Labyrinthodon Rütimeyeri, Wiedersheim, Abhandl., Schweiz. Pal. Gesellsch. v. 1878, p. 1–56.

Aristodesmus Rütimeyeri (Wiedersheim); Seeley, Ann. Mag. Nat. Hist. (6), Vol. 17, 1896, p. 183.

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CURRENT NOTES ON PHYSIOGRAPHY.

McGee on Sheetflood Erosion.

Sheetflood is a term coined by McGee (Bull. Geol. Soc. Amer., VIII., 1897, 87–112) to name the thin sheets of water that occasionally flow over the thinly gravel-covered intermont slopes of the Sonoran district in Arizona and bordering Mexico. It is contrasted with streams, in which a water current is gathered into a channel. Sheetfloods may be a mile or even ten miles wide, yet only a foot or two deep, running rapidly down slopes of one or two hundred feet to a mile; everywhere 'at grade;' that is, their ability to do work everywhere nicely balanced against the work that they have to do. By sheetfloods, not by streams, the peculiar gravel-covered rock floors of the Sonoran district are thought to have been planed down; and the abrupt transition from streams in the mountain gullies to sheetflood on the piedmont surface is taken to explain the equally abrupt transition from mountain to plain; the rocks remaining the same. Unlike the aggraded plains of the Utah, where intermont depressions are heavily filled with mountain waste, the

* *Basileosaurus Freyi* Wiedersheim (Über einen neuen Saurus aus der Trias. Mit einer Tafel. Abh. Schweiz. Pal. Ges., vi., 1879, 4 pp.) from Riehen is too insufficiently described and figured to determine its true position. It is doubtless a reptile, but, according to Wiedersheim, not *Sclerosaurus*.

rock plains of Sonora are only veneered with gravel and sand. At the outlet of mountain ravines McGee pictures and describes triangular, convex 'fans,' which are really carved in solid rock like the plains, and only veneered with alluvium. These must be retreating alluvial fans, in contrast to the advancing alluvial fans ordinarily seen in mountain valleys. After advancing for a time, fans of the latter class are often dissected by streams and thus worn away; but the Sonoran rock-fans seem to have been worn back by sheetflood action, thus preserving their form.

RELIEF MAP OF NEW JERSEY.

A HANDSOME and effective publication of the New Jersey Geological Survey is a new relief map of the State, on a scale of four miles to an inch. It is shaded in gray-brown, as if under northwest illumination, making the relief of the surface only too clear. The map will prove extremely serviceable, but it may be questioned whether a more delicate rendering would not have been more educative, particularly in the schools, where such a map as this must have its greatest and most important use. This is particularly the case in the southern part of the State, where the shading does not seem to be reduced to the delicacy of the faint inequalities in the surface, but where the inequalities of the surface are exaggerated to meet the demands of distinct shading and easy recognition. The effect produced by the southern plains does not tally with that gained on reading the text of the State Survey reports; it is as if the drawing of the relief map were done by a topographer accustomed to exaggerated sections on which an almost imperceptible natural slope becomes a distinct incline, rather than by a geographer who wished to give a just sense of the proportions of hills and plains. The criticisms directed against the vertical exaggeration of geographical models may be equally directed against so forcible a relief map as this. The map is headed with the names of John C. Smock, State Geologist, and C. C. Vermeule, topographer; but no explicit recognition is given to the artist who prepared the map or to the lithographer who printed it.

MORAINES OF THE MISSOURI COTEAU.

A REPORT with the above title by J. E. Todd forms Bulletin 144 of the U. S. Geological Survey. It is chiefly occupied with detailed descriptions of the moraines, from which one may gain a good idea of their importance in determining the relief of the Coteau. A map and many plates, apparently drawn in outline from photographs, afford good illustrations; but it is often difficult to identify localities between text and map. The Blue lake loop, 60 miles southeast of Bismarck, six to ten miles wide, is so rough, with so many stony hills and marshy hollows, as to present a formidable barrier to travel. One may easily lose his way on this undulating surface, where no conspicuous landmarks serve as guides. Many of the moraines are traversed by dry channels that once carried water from the melting ice sheet. The channels are now frequently occupied by small shallow lakes. The Ree hills, 40 miles east of Pierre, chiefly of Cretaceous beds with a veneer of drift, are traversed by an elaborate extinct drainage system; the main channel begins in a gap in the hills, receiving tributaries from either side on its way south, and gaining a depth of 60 to 70 feet with abrupt, stony sides, and a breadth of $\frac{3}{4}$ mile (p. 27).

NOTES.

THE two numbers of Appalachia for 1896 contain several good accounts of mountain ascents in the Canadian and Montana Rockies and in the High Sierra of California. A number of the plates are excellent; that of the Avalanche lake, Montana, being

particularly fine. Narrative, rather than physiography, characterizes the text; but much of the quality of our higher mountains can be gleaned from it. A sad interest attaches to the later pages, in the account of the death of Philip S. Abbot on Mt. Lefroy, Canada. The great precipices of the mountain are shown in a full-page plate.

The physiography of northern Indiana is described by C. R. Dryer (*Inland Educator*, IV., 1897, 63–69) as a contribution towards more rational geography in the schools. The region was first explained by Gilbert in 1870; the drainage is now shown to be even more dependent on morainic ridges than was at first supposed. North of the Maumee-Wabash line the moraines are heavier, enclosing numerous lakes and forming a most picturesque contrast to the flatter surface of the Erie clays around the lake border.

C. Sapper writes upon the physical geography and the geology of Yucatan (Bull. No. 3, Inst. geol. Mexico, 1896). A considerable area is described as of 'very strange topography;' lacking ridges of determinate direction, and everywhere gently undulating; the cause of this being ascribed to the horizontal position and the porous structure of the rocks, and to the 'sinks' consequently formed over subterranean channels. The same author describes the volcanoes of Salvador and southeast Guatemala (Petermann's Mitt., XLIII., 1897, 1–7). The volcano Guazapa is well dissected by radical valleys, while nearly all the others are young enough to have smooth contours.

John Murray, of the Challenger expedition, gives an account of 'Balfour shoal' (*Scot. Geogr. Mag.*, XIII., 1897, 120–134, two plates), probably a volcanic cone, rising from the Pacific bottom, east of Australia, in Lat. 19° S., Long. 157° E., from a depth of 1,300 fathoms to 836 fathoms. The side slopes are steepest on the northeast, where they reach 200 fathoms per mile, or 1 in 4.4. Examples of other oceanic cones may be found in a paper by G. W. Littlehales, entitled 'Average form of isolated submarine peaks,' published by our Hydrographic Office in 1890.

W. M. Davis.

Harvard University.

CURRENT NOTES ON ANTHROPOLOGY.

THE MONOLITHS OF TAFI.

Tafi is the name of a broad valley in the province of Tucuman, Argentine Republic. The well-known scientist, Professor Ambrosetti, in a recent visit there, had his attention called to an extraordinary collocation of monolithic pillars and stone enclosures, erected in remote ages by the native inhabitants. He describes them in *Globus*, Bd. LXXI., No. 11. The monoliths are from six to ten feet in height above the soil, some plain, others decorated with conventional designs, others rudely chipped into the likeness of faces, etc. They extend over a considerable area and their purpose is problematical.

Ambrosetti is inclined to attribute them to the predecessors of the Calchaqui Indians, who occupied this territory at the Conquest. He suggests that they are the work of the same people who erected the buildings of Tiahuanuco; a suggestion which I think is extremely probable, for some of the decoration shown in his cuts is strikingly like that on the stone pillars of Hatuncolla, two leagues from Lake Titicaca, portrayed in Squier's 'Peru,' pp. 385–6.

ETHNOGRAPHY OF THE MYCENEANS.

In the excellent volume on Mycenean art from the pens of Professors Tsountas and Manatt there is a chapter devoted to the ethnic affiliations of the peoples who, some two milleniums before the Christian era, developed that remarkable culture.

Their tombs, dwellings and arts point to

two different strata of growth, but both purely and originally European and Grecian. The influence of the Orient was late and slight. The two early migrations may be called Danaan and Achæan; but the chief fact remains that they were both of indigenous cultural development, not imported or exotic.

What is more, the later, historic Greeks directly inherited this culture, as is proved by the identity or close similiarity of architecture, ornament, pottery, arms, and religious and political institutions. This also is asserted by Homer and all early Greek tradition.

The linear and hieroglyphic writing, scantily represented in the Mycenean horizon, may point to Asiatic fonts; rather Anatolian (Hittite) than Phœnician; but the evidence is too slight to speak finally on this question.

D. G. BRINTON.
UNIVERSITY OF PENNSYLVANIA.

NOTES ON INORGANIC CHEMISTRY.

A PAPER was recently read before the Royal Society, by Dr. W. A. Tilden, on the gases enclosed in crystalline rocks and minerals. From the time of Brewster, observers have found in many crystallized minerals, notably in quartz, cavities containing gas, and often drops of liquid. Water, carbon dioxid, hydrocarbons and nitrogen and, more recently, hydrogen and carbon monoxid have been found. A large number of crystalline rocks—granite, gneiss, basalt, etc.—have been examined by Dr. Tilden, and the yield of gas varied from 0.65 volumes, in a recent (1760) lava from Vesuvius, to 17.8 volumes, in a gneiss containing corundum from Serringapatam. The gas is apparently contained in cavities which are visible in thin microscopic sections, but that these cavities are extremely minute is shown by the fact that there is practically no diminution of yield when the rock has been reduced to a coarse powder before heating. The largest portion of the gas is carbon dioxid and hydrogen, with nitrogen, methane, and carbon monoxid, each to the extent of a few per cent. In no case was any evidence of helium found. The presence of hydrogen and carbon monoxid is accounted for by the formation of the rock in an atmosphere rich in steam and carbon dioxid, which was or had been in contact with an easily oxidizable substance; this might be metallic iron, which has been found in basalts and other rocks. The presence of marsh gas in the rocks tends to support the view that in the interior of the earth's crust there are large masses, not only of metal, but compounds of metals, such as iron and manganese, with carbon. This view, first put forth by Mendeleef, which would account for the great deposits of natural gas, petroleum and other natural hydrocarbons, appears to be steadily gaining ground, and has received further support by the work of Moissan and others on the metallic carbids.

MAURICE DE THIERRY communicates to the *Comptes Rendus* determinations of atmospheric ozone on Mount Blanc, begun in 1894. At Chamounix the amount of ozone was 3.5 mg. per 1,000 cubic meters of air; on the Grand Mulets (elevation 3,020 meters), 9.4 mg., or nearly four times as much as at Paris. The conclusion is drawn that the amount of ozone increases with the elevation, a confirmation of earlier results. Hail, falling at an elevation of 4,200 meters, when placed on a sheet of iodo-starch ozonoscopic paper gave immediately circular violet spots of larger diameter than the hailstones and paler in the center, but it was not determined whether these spots were due to an atmosphere of ozone surrounding the stone, or to hydrogen dioxid from the melting hail. Neighboring snows, however, have never shown a reaction for hydrogen dioxid.

The Journal of the College of Science, Imperial University, Japan, quoted in the *Chemical News* for April 9th, gives the full description of the atomic weight determination of tellurium by Masumi Chikashige, already noticed in Science. Previous determinations have been made from tellurium associated with heavy metals, and the figure found, 127.6, is higher than that of iodin, below which it should be, according to the periodic law. It has been thought that some impurity of higher atomic weight might account for the anomaly. Chikashige worked with a tellurium of a wholly different (Japanese) origin, occurring associated with sulfur and selenium. He also reaches the same result, 127.6. It may, however, be noted that if the supposed contamination in the American and European tellurium be due to a higher element of the sulfur group, it would not be unnatural to suppose the same element present in the Japanese mineral, which contains 99.75 per cent. sulfur, 0.06 per cent. selenium, and 0.17 per cent. tellurium.

J. L. H.

ASTROPHYSICAL NOTES.

In *Circular No. 12* of the Harvard College Observatory, dated November 2, 1896, Professor Pickering published the discovery on the Draper Memorial photographs of a remarkable stellar spectrum, that of Zeta *Puppis* (Mag., 2.5; R. A., 8^h 0.1^m; Dec., $-39°$ 43′).

In addition to dark hydrogen lines and *K*, there were two broad bright lines at λ 4633 and 4688, and a peculiar series of dark lines whose wave-lengths were rhythmically related. These were λ 4544, 4201, 4027, 3925, 3859, 3816 and 3783. It was at first thought that they represented some new element not yet found on the earth or in the stars. *Circular No. 16*, of date January 12, 1897, announced, however, the important discovery that these lines are very probably due to hydrogen, being produced under conditions of luminosity not hitherto known. Professor Pickering finds that by writing Balmer's formula, connecting the wave-lengths of the hydrogen lines, in the form

$$\lambda = 3646.1 \frac{n^2}{n^2 - 16}$$

the ordinary lines will be given when for n the even integers 6, 8, 10, etc., are substituted, and the new lines when the odd integers from 9 to 21 are successively assigned to n. It appears that the lines for n = 7 (λ 5412), 9 (λ 4544), 11 (λ 4201) and 13 (λ 4027) have been hitherto recorded in certain spectra of type IIb. Professor Pickering has since reported that three other southern stars are somewhat similar to Zeta *Puppis* in having part of the lines of the new series.

Meanwhile Professor H. Kayser, of Bonn —whose work in conjunction with Professor Runge on the harmonic relations of spectral lines is so favorably known—also investigated the origin of the new lines, and publishes his conclusions in two articles in the *Astrophysical Journal* for February and April. Hydrogen had been the only element having harmonically related lines which had possessed only a single series of such lines. Now Kayser and Runge have found that two of the series of lines for an element end at nearly the same place. Hence on examining the frequencies of the new lines, Kayser concluded that they have this characteristic and represent a new hydrogen series, a conclusion confirmed in his second article written after seeing *Circular No. 16*. Thus the spectral relations of hydrogen lines become normal.

It is a matter of much interest to know if the lines of the new series can be produced in laboratory experiments. If so, important information as to stellar temperatures and pressures is likely to be o btained

THE Lick Observatory has just sent out Plates 2 to 5 of its *Observatory Atlas of the Moon*, finely reproduced in photogravure, on a scale of 38 inches to the lunar diameter, from the negatives obtained with the great refractor. The publication of this valuable series of photographs was made possible by the generosity of a citizen of New York, Mr. W. H. Law.

IN the *Monthly Notices* of the Royal Astronomical Society for January Mr. W. F. Denning contributes a catalogue of the real paths of 107 meteors, observed by himself and others in England during the last ten years. The averages are:

Height at first appearance	73.6 miles	(106 meteors)
Height at disappearance	45.3 "	(107 meteors)
Length of path	62.1 "	(105 meteors)
Velocity per second	26.9 "	(58 meteors)

The greatest height of any well-observed meteor was 126 miles. In the above averages no distinction was made between fireballs and shooting-stars.

IN the same number of the *Notices* Professor G. von Neissl, of Brünn, contributes a list of the real paths of 100 large meteors which have been authentically observed, chiefly in the last two decades. For these the average height when first seen was 91 miles. No. 77 of the list was visible from Servia to France, traveling in a real path of 1770 miles, from the hardly credible elevation of 483 miles to that of 115 miles. From a comparison of the catalogues of von Neissl and himself, Denning shows several instances of the recurrence of large meteors from the same radiant, indicating that they belonged to the same swarm.

E. B. F.

SCIENTIFIC NOTES AND NEWS.

MISS ALICE BACHE GOULD has given $20,000 to the National Academy of Sciences as a memorial to her father, the great astronomer, B. A. Gould. It will be known as the Gould fund and the income will be used to promote researches in mathematics and astronomy.

SIR HENRY THOMPSON has presented the Royal Observatory at Greenwich with a telescope said to be the most powerful instrument at present existing for the prosecution of astronomical research by means of photography. The photographic refractor has an object glass 26 inches in diameter. The photographs it will take will be on twice the scale of 2 mm. to one minute of arc, and its short focal length gives it great light-gathering power. The instrument now mounted at Greenwich has been in course of construction by Sir Howard Grubb, of Dublin, during the last three years.

THE Royal Observatory at Bonn has received from the state a preliminary appropriation of 30,000 Marks, which will ultimately be increased to 90,000 Marks, for the construction and mounting of a refracting telescope of medium size.

SIR WILLIAM FLOWER'S term o office as Director of the Natural History Departments of the British Museum has been extended for three years from the expiration of his retirement date under the age regulation of the Civil Service.

THE American Philosophical Society, Philadelphia, will hold a conversazione in honor of Sir Archibald Geikie on the evening of May 7th. Sir Archibald Geikie will make a communication on recent geological work in the Hebrides and Faroe Isles.

THE Council of the British Medical Association has conferred the gold medal of the Association on Mr. C. G. Wheelhouse and Sir Walter Foster.

THE Cothenius medal, *Leopold Carolinische Akademie der Naturforscher*, has this year been awarded to Dr. G. Quincke, professor of physics at Heidelberg.

DR. P. GRÉHANT, professor of physiology in the Paris Museum of Natural History, has been awarded 4,000 francs by the French government to promote his researches on the applications of physiology to hygiene.

MR. J. H. PRATT, instructor of mineralogy in the Sheffield Scientific School of Yale University, has accepted the post of mineralogist in the North Carolina Geological Survey.

M. PICOU was elected president and M.

Gosselin secretary of the *Société Internationale des Electriciens* at the last meeting of the Society held on April 7th.

Dr. Traill Green, emeritus professor of chemistry at Lafayette College, died at Easton, Pa., on April 29th, at the advanced age of eighty-four years. Dr. Green was first made professor in Lafayette College sixty years ago, and during that time took an important part in the building-up of the college, having been dean of its scientific department and having given it an astronomical observatory. He made many contributions to medicine and to other sciences.

We regret further to record the death of Miss Emily L. Gregory, professor of botany at Barnard College and the author of valuable contributions to botany, and also the deaths of Dr. de Marbaix, founder of the Bacteriological Institute at Boma; of Dr. Jakob Breitenlohner, professor of meteorology and climatology in the Vienna School of Agriculture; of Dr. Sinku Sakaki, professor of psychiatry in the University of Tokio, and of Dr. Victor Lemoine, formerly professor of the Medical School at Reims, and known for his contributions to comparative anatomy and paleontology.

Longmans, Green & Co. are about to publish a new and revised edition of Sir John Evans' 'Ancient Stone Implements, Weapons and Ornaments of Great Britain,' which has long been out of print.

The London *Academy* is publishing a series of portraits of eminent writers. The issue of April 10th contained an admirable reproduction of a photograph of Darwin, by Mrs. J. M. Cameron.

The British government authorities have presented Dr. Nansen, in recognition of his services in scientific exploration, with a complete set of the Challenger Reports. This is said to be the only case in which this great publication, extending to fifty volumes quarto, has been presented to an individual.

Dr. Carl Lumholtz, the Norwegian anthropologist, has returned to New York after having spent three years in the interior of Mexico in the interests of the American Museum of Natural History. He has secured valuable collections and much information regarding the aboriginal tribes.

It is stated in *Nature* that at the last meeting (April 14) of the Russian Geographical Society, Baron Osten Sacken read a telegram which he had received from Sven Hedin, the well-known Swedish traveler in Central Asia, announcing that he had crossed Tibet (Northern Tibet) by following a route which lies somewhat to the south of General Pyerstoff's route; during that journey he discovered 23 new salt lakes, four of which are of considerable size. Notwithstanding the great difficulties of the journey, and the loss of 44 beasts of burden out of 50, all collections are safe. From Tibet, Sven Hedin went through Mongolia to Pekin, and towards the end of May he expected to be in St. Petersburg.

M. Augustin Falconz has given the University of Lyons 100,000 francs to be used for biennial prizes, one for each of the four faculties of the University.

A chair of physical geography has been established in the faculty of sciences in the University of Paris, and M. Vélain has been appointed the first incumbent.

A memorial proposing a physical laboratory for India signed by Lord Kelvin, Lord Lister and other leading British men of science has been presented to the Secretary for India. The memorial is as follows:

"We, the undersigned, interested in the progress of physics, desire respectfully to draw your lordship's attention to the great importance which we attach to the establishment in the Indian Empire of a central laboratory for advanced teaching and research in connection with the Presidency College, Calcutta, the most important educational institution under the Government of India. We believe that it would not only be beneficial in respect of higher education, but also that it would largely promote the material interests of the country, and we venture to urge on you the desirability, therefore, of establishing in India a physical laboratory worthy of the great empire."

Professor D. T. MacDougal, in a letter to the *Botanical Gazette*, on the Tropical Laboratory Commission, states that Dr. J. E. Humphrey, accompanied by a number of advanced students in zoology from the Johns Hopkins

University, will carry on some investigations in the vicinity of Port Antonio, Jamaica, during the ensuing season, and that he has agreed to cooperate with the Commission in the examination of the island. In the arrangement of plans for the work of the Commission provision will be made for a repetition of a portion of the tour of investigation during the coming winter, in order to appreciate more fully the climatic possibilities of the more promising localities. The *Journal of Botany*, in an article expressing cordial approval of the undertaking, advocates one of the Lesser Antilles as the site of the laboratory, urging that a site in Mexico would be a hindrance to cooperation on the part of botanists in Great Britain on account of the length of the journey.

THE Friday evening meetings of the Royal Institution of Great Britain were resumed on April 30th, when Professor J. J. Thomson gave a discourse on 'Cathode Rays.' Succeeding discourses will probably be given by Professor Harold Dixon, the Right Hon. Lord Kelvin, Professor H. Moissan, Mr. W. H. Preece, Mr. William Crookes and others. The Tyndall lectures for 1897 are being given by Dr. Tempest Anderson, his subject being 'Volcanoes.'

THE Royal Society will hold the first of its two annual conversaziones on the evening of May 19th.

THE ninety-fifth anniversary of the founding of the Zoological Station at Naples was celebrated on April 14th. Addresses were made by Professor Todaro, representing the University of Rome and the Accademia dei Lincei by Dr. Eisig, of the Station; by Professor Waldeyer, representing the Berlin Academy of Sciences, and by Professor His, of Leipzig. Professor Dohrn was presented with the freedom of the city of Naples and the Grand Cordon of the Crown of Italy. After the German Ambassador had made a few remarks Professor Dohrn himself gave an account of the origin and progress of the laboratory whose work has been such an important factor in the progress of biological investigation.

SEVERAL members of the British Royal Commission on Tuberculosis, including Sir Herbert Maxwell, M. P. (Chairman), Mr. Harcourt E. Clare, Mr. John Speir and Mr. T. M. Legge (Secretary), accompanied by Professor M'Fadyean, started on April 22d for Brussels, Cologne, Berlin and Leipzig, in order to investigate the methods adopted on the Continent for dealing with tuberculosed meat. The Belgian and German Governments have made arrangements to aid the Commissioners in the investigations. The Commissioners expect to return about the end of the second week in May.

INVITATIONS have been sent for the sixty-fifth annual meeting of the British Medical Association, to be held at Montreal. The program is as follows: August 31st, 12 a. m.—Services in the English Cathedral. 2:30 p. m.—Windsor Hall, opening ceremonies and addresses of welcome. 3 p. m.—Address by the President-elect, T. G. Roddick, M.D., M.P. 4 p. m.—Garden parties, excursions around the mountain, etc. 9 p. m.—Soirée at Laval University. September 1st, 1. p. m.—McGill University, openings of sections (eleven in all). 3 p. m.—Windsor Hall: Address in medicine, by Dr. Wm. Osler. 4. p. m.—Excursion down the St. Lawrence, etc. 9. p. m.—Sohmer Park, conversazione and dance. September 2d, 9:30 p. m.—McGill University, sectional meetings. 1:30 p. m.—Lunch on the mountain. 3:30 p. m.—Windsor hall, address in surgery, by Mr. T. Mitchell Banks. 4:30 p. m.—Excursion across the Island, etc. 7:45 p. m.—Annual dinner of the Association, Windsor Hall. September 3d, 9:30 a. m.—McGill University, sectional meetings. 3 p. m.—Windsor Hall, address in public medicine by Herman M. Biggs and concluding general meeting. 4:15 p. m.—Excursion to St. Anne's and down the Lachine Rapids. 9 p. m.—Soirée at McGill University. September 4th.—Excursion to Ottawa, Quebec, Kingston, St. Agathe, Lake Memphremagog, etc.

CAMBRIDGE UNIVERSITY has made a slight provision for the study of experimental psychology, but the science is very inadequately represented in Great Britain as compared with Germany, the United States and France or even with countries such as Russia, Switzerland, Italy, Belgium and Denmark. We are glad to learn that an effort is now being made to intro-

duce the subject into University College, London. A committee, including Mr. Francis Galton, Professor Carl Pearson, Professor C. A. Schäffer and others, has been formed and subscriptions are invited for the purchase of apparatus and the establishment of a lectureship.

In an interesting historical sketch of the University of Minnesota, Professor C. W. Hall describes an important adjunct of the scientific work of the University—the Geological and Natural History Survey of the State. This was organized in 1872 and placed under the direction of the Board of Regents. The original cost of this work was $1,000 per year; this was soon increased to $2,000, and in 1875, and subsequently, 38,643 acres were turned over to the Regents to be disbursed in accordance with the law ordering the Survey. This land, at the minimum price of $5.00 per acre, for which it could be sold, will eventually enable the Regents to realize over $200,000. The cash appropriations which the State has at various times voted for the maintenance of this work amount at date to $50,000, not including cost of printing. The Survey is comprehensive in its scope. The fields of investigation named in the original act are geology, botany, zoology and meteorology. Two maps, a geologic and topographic, were also provided for; the latter, on approval, to become the official map of the State. A museum was also contemplated, which should exhibit to the people of the Commonwealth, in an orderly and scientific way, its natural resources as discovered by the Survey. The geological exploration of the State was first prosecuted. Botany, zoology, meteorology and topography are to follow in order, unless economy and efficiency can be secured by joint operations. The results of these investigations thus far available are to be found in a series of annual reports covering almost a quarter of a century of geologic work; three volumes on the final report of the geology of State; two brief reports of the State Zoologist, accompanied by a study of the birds of Minnesota, by Dr. P. L. Hatch, and a synopsis of the Entomostraca of Minnesota, by C. L. Herrick and C. H. Turner; one report of the State Botanist, containing an exhaustive review of the Metaspermæ of the Minnesota river valley; a series of bulletins, containing geological, botanical and zoological papers, besides many scientific papers from less comprehensive fields of study.

The *Electrical World* reports on a recent communication by M. d'Arsonval to the Société Internationale des Electriciens concerning the therapeutic and physiological effects of high frequency currents. He showed the powerful inductive effects which can be obtained with these currents. A striking experiment consists of placing three lamps in tension and allowing the current to pass through the body. These currents cause no sensations, and a man placed in a circuit does not feel that he is traversed by the currents which brilliantly illuminate the lamps. The principal results of this electrification are an augmentation of the oxidations in the organism and an increase in the production of heat. A subject who, under ordinary conditions, eliminates 17 to 21 liters of carbonic acid per hour throws off 37 liters after having been submitted to this action. High-frequency currents do not act solely upon the surface of the body, but also profoundly upon the interior. All of these results have been obtained upon a number of subjects by MM. Apostoli and Charrin. M. d'Arsonval cited, in closing, the action exercised upon microbes and bacteria by these currents. The microbes and bacilli are modified, and the toxines are killed and transformed to vaccine. MM. d'Arsonval and Charrin hope by this method to arrive at a direct treatment for the interior of the bodies of patients suffering with zymotic disease, and experiments to this end have begun.

We are extremely glad to note that the tariff bill, as amended by the Senate Finance Committee, includes the following additions to the free list:

Books, maps, music, engravings, photographs, etchings and charts, printed more than twenty years before the date of importation; all hydrographic charts and scientific books devoted to original scientific research, and publications issued for their subscribers by scientific and literary associations, or publications of individuals for gratuitous private circulation, and public documents issued by foreign governments.

Books printed exclusively in foreign languages for the blind.

Books, maps, etc., especially imported, not more than two copies in any one invoice, for the use of any society or institution established solely for religious, philosophical, educational, scientific or literary purposes, or for the encouragement of the fine arts, or for the use of any college, school or public library, and not for sale.

Paintings, original drawings and sketches, engravings and statuary, not otherwise provided for; paraffine, philosophical and scientific apparatus for schools, libraries and societies; professional books, implements and instruments, and tools of trade or occupation in the actual possession at the time of persons arriving in the United States; regalia and gems, statues, casts of marble, bronze, or alabaster, where specially imported in good faith for the use of any society, school or library.

UNIVERSITY AND EDUCATIONAL NEWS.

THE will of the late John Foster, of Boston, gives $120,000 to public purposes, including $10,000 to the Massachusetts Institute of Technology.

THE will of the late Charles Bell, of Springfield, Mass., bequeaths $7,000 to Wellesley College for a scholarship fund.

BROWN UNIVERSITY receives $10,000 by the settlement of the will of the late Mrs. Maria L. Benedict, of Providence.

PROFESSOR H. L. HUTCHIN, Dean of the Law Department of the University of Michigan, has been offered the presidency of the University during President Angell's absence in Turkey.

MR. C. H. WARREN has been appointed instructor in mineralogy in the Sheffield Scientific School of Yale University.

THE Spanish universities and other educational institutions under state control have just been thrown open to foreigners by royal decree. By the new ordinance foreigners are admitted to the right of matriculation, study and examination in all educational establishments under the Spanish government, and are entitled to take degrees in the universities.

IN announcing last week the promotion of Professor Albert Bushnell Hart, of Harvard University, it was accidentally stated that his chair was physics; it should, of course, have been history.

DISCUSSION AND CORRESPONDENCE.

TYPE SPECIMENS IN NATURAL HISTORY.

A RECENT number of SCIENCE* contains an article by Mr. Charles Schuchert, entitled 'What is a Type in Natural History?' The title is misleading, for, instead of discussing type forms or types of groups, Mr. Schuchert confines his attention to type specimens, and chiefly to the names by which such specimens may be designated, in which direction he shows remarkable fertility of resource. In view of these facts, and of the additional circumstances that the subject is approached from the standpoint of the student of fossils, his paper might have been better described under some such heading as 'Suggestions for the Multiplication of Type Specimens in Paleontology.'

Mr. Schuchert revives several obsolete terms, such as *paratype* and *metatype*, which have never been used, so far as I am aware, even by the man who proposed them, and adds a number of his own invention, such as *genotype*, *holotype*, *hypotype*, *plastotype* and *hypoplastotype*. These may be taken as mild examples of a prevalent and apparently incurable form of mania which busies itself in burdening science with a useless and formidable terminology. The most serious objection to such terms is the discouraging effect they have on students, for they wall in a subject with a barrier that few have the courage to assail. In my own case I am bound to confess that, although the greater part of my life has been spent in the study of animals and plants, I am to-day unable to read half the literature on these subjects, because of the multiplicity of technical terms by which the author's meaning is made unintelligible. Life is too short and too precious to be fritted away in memorizing such a disheartening and ever increasing mass of terminology.

My reasons for replying to the article in question are, first, to make the occasion an excuse for filing a protest against the unlimited coinage of new terms, and second, to assure the amateur and beginner that in descriptive zoology and botany these particular terms are wholly unnecessary. In practice the best systematic

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writers find the single word *type*—understood the world over—sufficient for ordinary needs. But in cases where a species rests on more than one specimen, and the author neglected to indicate a type, the term *cotype* is used to designate each of the several specimens on which the original description was based. Still another term is found convenient and is in common use among mammalogists. It is the word *topotype*, proposed by Mr. Oldfield Thomas, and used to designate a specimen from the identical locality from which the type specimen of a species came. Among plants and non-migratory terrestrial animals, topotypes are, after the original types, the most valuable study material a museum can possess.

In paleontology, where it is customary to describe new species from very fragmentary material—such as the tooth of a mammal or the leaf of a plant—which is afterwards supplemented by the discovery of additional parts, it becomes convenient, as pointed out by Mr. Schuchert, to consider the later and more perfect specimens, from which additional characters are derived, as *supplementary types*. This, however, hardly seems sufficient provocation for the introduction of a special set of new terms. Nevertheless, if paleontologists really feel the need of these terms I suppose the rest of us should try to bear them with becoming fortitude; but would it be too much to ask that they be considered as proprietary material and not let loose on the whole field of systematic biology?

It is pleasing to note that Mr. Schuchert is a firm believer in the priceless value of type specimens and that he advocates the use of special colored labels to distinguish them from others. Fortunately the use of such labels for this purpose is rapidly becoming general. It might be added that as a rule type specimens should not be placed in the exhibition series in public museums, but should be carefully preserved in special cases devoted exclusively to such material. The exhibition in glass cases of type specimens of animals injured by light—as birds and mammals—indicates a disinterestedness amounting almost to criminal neglect.

While discussing the matter of types I would like to digress sufficiently to express the conviction now shared by a large body of working naturalists that type specimens, being units of comparison, should from the nature of the case be single, not multiple. It is the common experience of naturalists that in a considerable percentage of the cases where several specimens have been used as types, subsequent study has shown these specimens to belong to different species, and in some cases to different genera. Is not this fact alone an unanswerable objection to the existence of more than one type specimen of a species?

C. Hart Merriam.

SCIENTIFIC LITERATURE.

Spencer's Principles of Sociology. New York, D. Appleton & Co. 1897. Volume III., pp. x + 645.

This volume completes not only Mr. Spencer's great work on 'The Principles of Sociology,' which in itself is an undertaking quite sufficient to establish the permanent reputation of any one man; but also the system of 'Synthetic Philosophy,' which was begun more than thirty-six years ago, and has been carried forward under circumstances of extraordinary difficulty. The system as it now stands in its final form includes the volume entitled 'First Principles,' in which the general doctrine of evolution is formulated in abstract terms; two volumes on 'The Principles of Biology,' two on 'The Principles of Psychology,' three on 'The Principles of Sociology' and two on 'The Principles of Ethics.'

No other mind in our generation has attempted to grapple so seriously with so many great subjects as Mr. Spencer has done; no other one thinker has so impressed himself upon all serious investigators in each of the great branches of scientific knowledge. Very few professional biologists are more frequently quoted than Mr. Spencer in works on biology; few, if any, professional psychologists are so frequently quoted in works on psychology; few, if any, professional writers on ethics are so frequently quoted in discussions of morals. This one fact is a significant index of Mr. Spencer's range and power. Even if it be true that the expert in each of the sciences mentioned disagrees with Mr. Spencer's conclusions on vital points, it is an astonishing achieve-

ment for any one man to have so impressed himself upon the best thought in so many fields of mental activity that all whose life work is concerned with these subjects find it necessary to define their relations to one such comprehensive thinker.

Of Mr. Spencer's 'Principles of Sociology' it must be said, first, that it should not be judged with reference to any conclusion that the critic may have reached upon the question whether or not there is a science of society. The phenomena of society are the most complex and perhaps the most elusive with which a serious student can deal. It may be that scientific opinion will presently be practically unanimous that no laws of social causation can be formulated which can be placed in the same category with those laws that make up the physical sciences. It will not follow, however, that society cannot be studied in a scientific spirit and by scientific methods. Whether or not, then, Mr. Spencer has created a science of sociology, he has at least demonstrated that social phenomena can be studied with scientific seriousness, and that if we do not thereby establish positive laws of social causation we shall, at least, attain to broader and truer views of social organization, of our personal relations to our fellow men and of the expediency of various schemes of governmental policy.

Of the wealth of illustration, the enormous array of facts which Mr. Spencer has brought together in these volumes, it is desirable to say that they have been made the subject of some unjust criticism. It is true that Mr. Spencer has depended upon the reports of travelers, explorers and missionaries for the greater part of his material; it is true that the observations so obtained have not always been made with critical discernment; but, on the other hand, it is to be remembered that comparatively little work has ever been done in sociological observation by trained observers. The test, therefore, that should be applied to Mr. Spencer's data is the question: "Has he on the whole made a discriminating and critical use of such material as was available?" When judged by this standard, Mr. Spencer's work in sociology will be found to be above the average level of treatises on anthropology and ethnology.

It is not necessary to speak in detail of Mr. Spencer's analysis of social organization or of his interpretation of social progress, as these things have become already familiar to the general reader. The organization of society, like that of the plant or of the animal, becomes complex through differentiations of activities and of groupings; it becomes unified through the integration of small communities into great nations. Social change, on the whole, is a progress from homogeneity to heterogeneity, in both activity and organization. Another point, however, and the one which is really vital in Mr. Spencer's philosophy of human relations, may be emphasized, because it is too often overlooked. Mr. Spencer does not admit that human nature is unchanging. Character, like everything else, undergoes a progressive modification. The environment and circumstances of a community are the environment of the individual character. Under conditions favoring industry and peace human nature develops the virtues of gentleness, truthfulness and industry; under conditions necessitating prolonged or chronic warfare human nature becomes cruel, tyrannical or subservient, untruthful, all that is vicious. This contention is maintained in all of Mr. Spencer's sociological writings, and is the chief proposition of 'The Principles of Sociology,' recurring again and again in the successive parts on Domestic, Ceremonial, Political, Ecclesiastical, Professional and Industrial Institutions.

Mr. Spencer's final conclusions, as he surveys the civilized world at the present moment, are somewhat despondent. He sees everywhere the revival of the military spirit and he looks for a marked deterioration of individual and national character in the immediate future. Of the more distant future, however, he expects better things, and at the conclusion of his work he renews the prediction which he made nearly fifty years ago: "The ultimate man will be one whose private requirements coincide with public ones. He will be that manner of man who, in spontaneously fulfilling his own nature, incidentally performs the functions of a social unit, and yet is only enabled so to fulfil his own nature by all others doing the like."

FRANKLIN H. GIDDINGS.

The Crowd. A Study of the Popular Mind. By Gustave Le Bon. The Macmillan Co.

This is a translation of a little volume entitled 'Psychologie des foules,' which appeared in Paris in 1895. The author is well known in the European scientific world as a voluminous writer upon many branches of physiology and psychology, and in recent years more especially as a student of the psychology of races and of mankind as socially organized.

In the present work M. Le Bon devotes his attention to an analysis of the psychological phenomena of masses of men. The substitution of the unconscious action of crowds for the conscious activity of individuals, he tells us, is one of the principal characteristics of the present age. The epoch is one of those critical moments in which the thought of mankind is undergoing a process of transformation. The general destruction of those religious, political and social beliefs which were the elements of an earlier civilization has been succeeded by new intellectual conditions of existence, the product of scientific thought and industrial discoveries In this critical transition period we are witnessing also the transformation of social organization from monarchical and aristocratic forms to democracy. Our author declares that we have entered, or we are about to enter, upon an age that may truthfully be described as the era of crowds. While only two generations ago the opinion of the masses scarcely counted in political affairs, to-day it is the old traditions and the opinions of individuals that are without influence. The voice of the masses has become preponderant.

What effect is this rule of the crowd to have upon civilization? In the past, civilizations have been created and directed by a small intellectual aristocracy, never by the crowd. Crowds, thus far in the world's history, have been powerful chiefly for destruction. Obviously, before we can answer any question in regard to the probable future action of crowds, we shall need to know much more of the psychology of collective men than we know at present. The thoughtful public should be grateful to M. Le Bon for this first serious attempt to analyze the mind of the crowd. One need not accept all of his conclusions to appreciate the value of his work. Its importance consists in the fact that he has clearly stated a large number of problems which merit diligent consideration—problems which hitherto have not been seriously studied as the foundation of political science.

The starting point of M. Le Bon's philosophy of crowds is a conviction that the crowd is always something more than the sum or the average of its individual elements. Our author believes that when men become organized as a crowd they lose many of their individual characteristics and acquire others which, as individuals, they never exhibit. The crowd is always, according to M. Le Bon's observations, swayed by feeling rather than by reason. This is because men differ more widely in intelligence than in feeling. The mental unity of a crowd, therefore, is sympathetic rather than rational. Again, crowds are undoubtedly to a very great extent subject to suggestion and to hypnotic influence. So far as the mental operations of crowds are intellectual they think in images, and are therefore in a large measure controlled by imagination. Like children, crowds are impatient of any obstacle interposed between suggestion and act; they desire to carry a purpose into immediate effect. They are, therefore, intolerant of discussion and of delay.

These truths, M. Le Bon declares, have always been instinctively apprehended by men with a genius for leadership. The imagination of crowds is awakened by whatever presents itself in the shape of a startling and effective image, freed from all accessory explanations. The leader, therefore, will take care to lay things before the crowd as a whole, and will carefully avoid any attempt to justify them on grounds of reason or to explain their origin. No man ever so thoroughly understood this truth as the first Napoleon. "It was by becoming a Catholic," he said to the Council of State, "that I terminated the Vendéean war; by becoming a Musselman that I obtained a footing in Egypt; by becoming an Ultramontane that I won over the Italian priests, and had I to govern a nation of Jews, I would rebuild Solomon's temple."

In general, crowds are powerless to hold other opinions than those which are imposed upon them by example or authority, and are not to be controlled by rules based upon theories of

pure equity or of economic expediency. They are rather to be directed, if at all, by seeking what produces an impression on them and what seduces them. The danger to civilization in this psychology of crowds lies in the fact that the dogmas whose birth we are now witnessing will soon have the force of old dogmas, that is to say, the tyrannical and sovereign force of being above discussion. The divine right of the masses is about to replace the divine right of kings. Nevertheless, M. Le Bon affirms that it would be dangerous to meddle with the organization of crowds, notwithstanding their psychological inferiority. The facts of history have demonstrated that social organisms are every whit as complicated as those of all beings, and it is not in our power to force them to undergo any sudden or far-reaching transformation.

M. Le Bon's account of the general psychology of crowds is supplemented by a detailed analysis of more special characteristics, in separate chapters on the sentiments and morality of crowds, the ideas, reasoning power and imagination of crowds, the religious shape assumed by the convictions of crowds, and the immediate factors of the opinions of crowds. In the latter part of his volume he describes different kinds of crowds, including criminal crowds, electoral crowds and parliamentary assemblies.

The chief criticisms to be passed upon this volume are: First, that the author has not acknowledged, as he should have done, his very obvious indebtedness to the greatest living social psychologist, M. Tarde, whose 'Les Lois de l'imitation' and 'La logique sociale' contain in their original form many of the suggestions which have governed M. Le Bon's thoughts. Second, that he makes rather too much, probably, of what he would call the hypnotic phenomena of crowds, and too little of the absence of personal responsibility which the individual feels when he unites with his fellowmen in collective action.

FRANKLIN H. GIDDINGS.

Laboratory Practice for Beginners in Botany. By WILLIAM A. SETCHELL, PH. D., Professor of Botany in the University of California. New York, The Macmillan Company. 1897. Pp. xiv+199. Price, 90 cents.

There are already a number of laboratory guides in elementary botany and, judging from the announcements of book publishers and their statements in conversation, there are soon to be several others. Their multiplication only argues that no single outline will satisfy other teachers. No good teacher can follow closely the outlines of instruction laid down by another; each must throw his own personality into the work and the method, and the conditions of time, place and facilities for work will all enter into the problem of how to teach an introductory class in botany. The author of the work in hand recognizes this condition when he says (p. 137): "The ideal way is to teach the student without any book."

The book illustrates what we regard as a false principle of instruction, though one much in vogue, namely, the telling a pupil in advance to see certain things before he has had a chance to look for something himself; this, followed too closely, can only result in preventing the development of any originality in the pupil and tends to reduce him to a mere machine. To illustrate the method followed, we quote from one of the chapters:

"I. Take a piece of stem of the Japanese Quince, which has several leaves attached to it. Examine the leaves and notice that:

"1. They are all borne on the sides of the stem (*i. e.*, that they are *lateral structures*).

"2. They are broad and thin (*i. e.*, they are also *expanded structures*).

"3. Their color is green. (This is not true for all leaves, *e. g.*, examine the leaves of some common red Colias [*sic*] of the garden or greenhouse, in which another coloring-matter is present and hides the green.)

"4. They are all borne at the *nodes* of the stem. (We may consequently separate that portion of the plant above the root into a number of similar parts, each of which may be called a *phytomer* or plant part. Each phytomer will consist of an *internode*, and a *node* with its *leaf* or *leaves*. Sketch a phytomer of the Japanese Quince and label it.")

This criticism is, of course, general, applying to many books of its class that have been

adapted to students of various grades in various subjects. They may be useful for giving suggestions to teachers who are themselves poorly prepared, but are not of the character to be placed in the hands of the beginning pupil. The pupil, to again quote the sentiment of the author, should be taught without books.

Treated, however, as a book for the instruction of teachers, this work possesses many meritorious features, among which we may mention:

1. It outlines work that can be accomplished without the aid of a compound microscope. This is highly important, because many schools cannot be equipped with compound microscopes, and what is a better reason, because a pedagogical one, it will prevent pupils becoming familiar with the compound microscope before they have exhausted the possibilities of the simple one. Botanical perspective cannot be attained by looking down the tube of a compound microscope alone, and the failure to learn how to use the unaided eye or a simple lens has been responsible for some of the lack of perspective in the rising generation of botanists.

2. It emphasizes the ecological side of botany, which is destined to be the next ruling feature of elementary botanical instruction.

3. Its list of required laboratory books for the teacher is short but excellent, and emphasizes the feature last named in such books as those of Kerner and Selina Gaye, and rigidly excludes manuals and other works on systematic botany which belong to a later stage in the evolution of botanical students.

Besides the general criticism given above, which falls on this book only as one of a special class, there are features peculiar to itself that could be improved. For example, it combines, among many suggestions suitable to the age of the pupils for which the work is intended, some that seem infantile and others that savor of pedantry or at least belong to children of a larger growth. Such expressions as 'strophiole,' 'phytomer,' 'reclinate præfoliation' and 'indeterminate anthotaxy,' might well be deferred to a later stage of instruction, if introduced at all. Then the work gives a more fragmentary treatment of the spore-producing plants than would be expected from a specialist in cryptogamic botany, tending, as was the case with Dr. Gray's text-book, on which this is quite closely patterned, to create the impression that all plants produce flowers or at least all that are worth considering. Besides leaving out a half of the plant world, and an important half at that, this plan hides away from the student the great principle of evolution of plant life which would be impressed upon him unconsciously were the study to commence with lower forms or at least give them a fair amount of attention. It is amazing how much knowledge of these lower plants can be gained by means of a simple magnifier, and it is unfortunate, to say the least, to prevent the student, however young, from getting a well-rounded conception of the whole subject. There are some few obsolete expressions in the book like 'stomata or breathing pores' and occasional typographical slips that it is always difficult to avoid in a first edition. On the whole, the merits of the work are much greater than its demerits, and if used by teachers alone, and not by students, it is probably as good or better than most the books of its type.

L. M. Underwood.

Essai critique sur l'hypothèse des atomes dans la science contemporaine. Arthur Hannequin. Annales de l'Université de Lyon. Tome Septième. Paris, G. Masson. 1895. Pp. 419.

This is an interesting and important book of its kind, but it is also a kind of book which to many physicists will need justification. It is a serious attempt to form a philosophy of atomism, and as such will be found to contain too much physics to please most metaphysicians and too much metaphysics to please physicists. That each party in the case may take his own, the book is frankly divided into two parts, the first having to do with atomic theory as actually found in science, and the second with the metaphysics of this theory. But it would be too much to hope that the physics and the metaphysics of atomism had actually been disentangled and separated. Whatever the metaphysician may do the wise physicist will read the whole book if he wishes to get M. Hannequin's complete message.

The book is written in a charming style, picturesque without loss of dignity and vivacious without flippancy. The discussion is at once so orderly and so complete as to give a high impression of unity and elegance. To one interested in the subject the book will prove easy and delightful reading. While we have in English many books upon parts of the field and many special investigations concerning molecular action we have yet no general work like this upon the foundations of atomism. Stallo's Modern Physics comes nearest to it and, although elementary in character and limited in scope, deserves to be better known than it is.

It is easy to see that the main interest of the author is philosophy and yet he shows everywhere wide and thorough reading in the history of atomistics and also in modern physics and mathematics. But with competent knowledge his perspective is often false. Leibnitz, though not better known, seems distinctly nearer to him than Maxwell, and he does not scruple to put down Cantor with a quotation from Descartes. Indeed the book is not only scholarly, but distinctly scholastic. This is perhaps the reason why the author takes everywhere a hard and fast view of science as a fixed body of knowledge instead of the growing, elastic, tentative thing that it really is. Having proved that the universe cannot be explained by the atom of Greek philosophy, a hard, round, indivisible solid, without parts or qualities, he fails to do justice to, although he shows a full consciousness of, modern atomistic speculation. M. Hannequin's statement on page 225, and everywhere implied throughout the book, that "the rigorous unity and the perfect simplicity of an explanation are the highest guarantees of its truth," should be limited to pure science. For experimental science this is an early and naïve view. The universe, and every part of it, is infinitely complex and diverse, and any view that makes it small and plain is the view of innocence, or of one who cares more for method than for matter.

The argument of the book runs in part as follows:

As the mind knows completely only what it creates—knows of things only what it projects into them—so science is rigorous and exact in such measure as it is a creation of the mind. Science takes its rise in the human need of rendering intelligible that which falls beneath the intuition of the senses. Number the mind has created and so knows completely, but extension and direction the mind cannot know directly. It can know these categories only by breaking them up into equal parts and counting them, that is, by *measuring*.

The first step in progress is the reduction of the physics of fact and phenomenon to the physics of law, which in its more generalized form becomes the physics of succession and change. The fundamental change—change of place or motion—turns one side toward fact and the other toward a rigorous mathematic, in terms of which the laws of succession and change are expressed. Thus science becomes universal in motion only as it breaks up its continuity by number. So we triumph over continuity by dividing it into units of time and mass, units small enough to measure any time and any space. These units, *the differentials of mathematics*, are the atoms of pure science—of geometry, of algebra, of kinematics, etc. Thus atomism is a necessary hypothesis growing out of the nature of knowledge.

So far we follow our author mainly with satisfaction, even in his long argument to prove that number and measurement are fundamental in geometry. A straight line is the shortest distance between two points; found shortest by measuring. Other definitions of a straight line he endeavors to reduce to the same notion. But all lines are made up of straight lines, and all figures are bounded by lines, so that all figures bear about with them quantitative relations. To arrive at this conclusion he ignores projective geometry, and discredits transcendental geometry by arguments which are familiar.

But the atom in pure science is a concept, the object of a definition. We must not project it into the real world. So how about atomism in nature? This is, of course, the main theme of the book, and is pursued through the various fields of chemistry, mineralogy, optics, electricity, etc., with intelligence and thoroughness. Mainly he will carry the great body of physicists with him. Sometimes he will part company with them; as when he insists that

the atom must have volume if it has mass, and that equal elementary masses imply equal volumes; when he attempts to disprove the possibility of a vortex atom in a homegeneous fluid; when he tries to prove the conception of atoms as centers of force inconsistent with the idea of mass; and in many details of his argument.

With greater success he exhibits the inconsistency and incompleteness of molecular theory in chemistry; shows the inadequacy of the hypothesis of a single ether or a multitude of ethers to explain action at a distance; of the hypothesis—'that scandal of atomistics'—of molecular atmospheres to explain attraction and repulsion; and, in general, of any hypothesis of an indivisible element to explain elasticity and other properties of matter. He compels us to see that our analysis only draws out of the atom what we have put into it; that, indeed, the atom of modern physics is a little world, almost organized, upon which are assembled all the properties and dynamic relations which it was to have been their mission to explain.

E. A. Strong.

Ypsilanti, Mich.

SCIENTIFIC JOURNALS.

THE AMERICAN JOURNAL OF SCIENCE.

The leading article of the May number is a biographical paper about the late Professor Hubert A. Newton, by J. W. Gibbs. It presents a brief account of his life and estimate of his personal character, and besides gives an extended and thorough summary of his contributions to astronomical science. This paper was read before the National Academy of Sciences at the recent meeting in Washington.

A. G. Webster discusses a method of producing constant angular velocity in cases where a considerable amount of power is needed, as in driving a large telescope or siderostat. It is based upon the use of a tuning fork which interrupts an intermittent current and thus regulates an electric motor. Some experiments show that the method is a practical one up to more than one and a-half horse power. The same author also discusses a method for rapidly breaking powerful electrical currents. The end is accomplished by making the break under water while the mercury surface employed is kept clean by being continuously elevated by means of an aspirated pump. By this means the jet is kept cool and presents a continually fresh surface of mercury, this being washed by the flowing water. The apparatus was found satisfactory in a current of twelve mean ampéres carried on for the course of an hour.

John Trowbridge, following out the line of discussion involved in the paper in the April number, discusses the 'Electrical Conductivity of the Ether.' By the method employed the author thinks he obtains an estimate of the energy required to produce the Röntgen rays and also a measure of resistance of sparks in air and different media. He closes thus: "It shows conclusively that the discharge in a Crookes tube at the instant when the Röntgen rays are being emitted most intensely is an oscillatory discharge. In popular language it can be maintained that a discharge of lightning a mile long under certain conditions encounters no more resistance during its oscillations than one of a foot in length. In other words, Ohm's law does not hold for electric sparks in air or gases. Disruptive discharges in gases and in air appear to be of the nature of voltaic arcs. Each oscillation can be considered as forming an arc. It is well known that a minute spark precedes the formation of the voltaic arc in air. The medium is first broken down and then the arc follows. I believe that this process occurs also in a vacuum and that absolute contact is not necessary to start the arc. My experiments lead me to conclude that under very high electrical stress the ether breaks down and becomes a good conductor."

T. W. Richards and John Trowbridge discuss the effect of great current strength on the conductivity of electrolytes. Experiments were made with copper sulphate and zinc sulphate, and the conclusion is reached that the conductivity is not essentially affected by great changes in the strength of the current.

H. S. Williams has a paper on the Southern Devonian formations, especially in southern Virginia, Tennessee and Kentucky, where he has recently carried on personal observations. He shows the remarkable contrast which exists between the formation as known in New York State and that as developed in the South, where

it is characterized by a uniform black shale with even sedimentation. An hypothesis is advanced to account for this difference and some broad fundamental principles laid down which apply to such problems in general. C. D. Walcott gives a brief description of a new species of *Lingulepis* from the Middle Cambrian, in the Yellowstone Park.

A. W. Duff discusses the secondary undulations of the water surface noted in tidal observations on the Bay of Fundy. At Indiantown, near St. John, New Brunswick, slight fluctuations of level were noted on a calm day, which had a fairly constant period of thirty-five seconds. There was found also a series of larger undulations obtained in the record which had a period of from thirty to forty minutes. Both series ceased at about the same time—about half an hour after high water. In connection with these, the author reviews observations made by various authors on the *seiches*, particularly those of Forel on Lake Geneva. It is shown that Forel's formula gives with fair accuracy the proper period for the secondary undulations, but while the Swiss *seiches* are regarded as connected with the abnormal conditions of the barometer, no such relation appears to exist in the case here described.

S. L. Penfield and H. W. Foote describe a new silicate from Franklin Furnace, N. J., to which they give the name Rœblingite, which is remarkable in containing sulphur dioxide (SO_3) and lead.

THE AUK.

THE April number opens with two papers on the spring plumage of the bobolink, respectively by Arthur P. Chadbourne and Frank M. Chapman, the first being illustrated with a colored plate. Dr. Chadbourne describes a case of the change of color in a caged male bobolink to the spring dress without any loss or renewal of feathers, whereupon he claims that 'color change in the individual feather is fact, not theory,' and that "the change to the breeding dress in the male bobolink sometimes takes place without a so-called 'moult.'" Mr. Chapman's paper is to some extent in the nature of a rejoinder to Dr. Chadbourne's, especially in respect to a specimen of a moulting spring bobolink from Corumbá, Brazil, which Dr. Chadbourne regards as acquiring the breeding dress partly by moulting and partly by change of color in the feathers themselves, an interpretation, which, Mr. Chapman claims, is quite without basis in fact as regards the feathers alleged to be changing color.

Charles W. Richmond describes ten new species of birds from the Kilimanjaro region of East Africa, collected by Dr. W. L. Abbott; A. W. Anthony describes several new birds from Lower California; W. W. Price describes a new pine grosbeak from California, and Leonhard Stejneger a new guillemot from the Kuril Islands. Harry C. Oberholser discusses at length the characters and relationships of the Western forms of the long-billed marsh wren, describing a new subspecies. William Leon Dawson gives an interesting annotated list of the birds of Okanogan county, Oregon; and A. W. Butler writes of various rare birds occurring in Indiana, including an account of the recent remarkable occurrence of Brünnich's murre far inland.

The department of 'General Notes' includes, as usual, a large number of notes on rare or little known species, and a number of important nomenclatural notes; 'Recent Literature' contains sixteen pages of reviews and notices of recent ornithological publications; 'Correspondence' and 'General Notes' complete the number, which is much larger than usual and is filled with matter of unusually varied interest.

SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF WASHINGTON—275TH MEETING, SATURDAY, APRIL 10.

DR. THEO. GILL and Mr. C. H. Townsend presented by title, 'Diagnoses of New Species of Deep Sea Fishes.'

Dr. Jonathan Dwight, Jr., under the title, 'A Species of Shearwater (*Puffinus assimilis*, Gould) New to the North American Fauna,' noted the occurrence of this species as a straggler, on Sable Island, on September 1, 1896.

Mr. Sylvester D. Judd spoke on 'Antennal Circulation in Crangonyx.'

Mr. Charles T. Simpson read 'Notes on the Classification of *Unios*,' being a brief sketch of the anatomical work of Lea, Agassiz, Kirtland

and Sterki. The speaker stated that there are two great groups of *Unios* in North America. The first is characterized by different forms of shells and branchiæ in the male and female. The shell of the latter is swollen in the post-basal region, a character wanting in the male, and the outer branchiæ are developed in this region into a marsupium. The shells of this group are generally highly colored, without a ridge on the dorsal slope, not arcuate, have delicate beak sculpture, and the assemblage is no doubt entitled to generic rank, for which the name *Lampsilis*, proposed by Rafinesque and again by Agassiz, may be used.

In the other great group the shells of male and female are essentially alike, being generally dull in color and arcuate in old age, having usually coarse beak sculpture and a posterior ridge. It is not certain that the sexes are always separate. In one subdivision of this group the shells are oval to oblong, and the embryos are contained in the whole of the outer branchiæ; in the other the shells are heavy, short, often tuberculous, and have the embryos generally distributed throughout all four leaves of the branchiæ. This great group is retained in *Unio*, and it is believed that in anatomical characters it closely agrees with the forms of Europe. The Australasian *Unios* are very much like those of South America in shell and anatomical characters and are classed as a separate genus, *Diplodon*. The two naiad faunas may be relics of an older Northern fauna, which was superseded by more modern forms, or it is possible that they may be parts of a Southern fauna that has migrated along a now sunken Antarctic continent.

Mr. Harry C. Oberholser discussed 'the American Golden Warblers,' with particular reference to their geographical distribution. He recognized twenty forms of this difficult group, one-half of which he considered subspecies. The Boreal and Austral regions of North America and Mexico together possess five forms, probably all races of a single species; the Central American subregion of the Neotropical has four; the Columbian subregion four; and the Antillean subregion seven. Various anomalies of distribution were pointed out and commented upon.

Mr. T. Wayland Vaughan gave some 'Notes on a Monograph of the Eocene Corals of the States,' stating that until recently they had not been well understood, although the United States possessed the richest Eocene coral fauna of any country. The original species came almost entirely from the Jackson stage and Lower Claiborne beds, and the material was often so water-worn as to be unrecognizable. Certain genera are well characterized and easily identified; others are so close as to run together. Virginia and Maryland constitute one fauna, containing their own peculiar species; the Gulf States constitute another, while California contains only three species, all endemic. This fauna as a whole belonged to shallow rather than deep water. No species of the American Eocene can be referred to the foreign Eocene.

F. A. Lucas,
Secretary.

AMERICAN CHEMICAL SOCIETY.

A special meeting of the New York section of the American Chemical Society was held at the College of the City of New York on Friday, April 23d. Dr. C. B. Dudley, President of the Society, presided.

Dr. E. K. Dunham, of Carnegie Laboratory, New York, read a paper on 'The Value of Bacteriological Examination of Water.' The discussion was opened by Dr. W. T. Sedgwick, Director of the Biological Laboratory of the Massachussets Institute of Technology. Dr. J. J. Kinyoun, of the United States Marine Hospital Service; Dr. W. P. Mason, of the Troy Polytechnic Institute; Dr. A. R. Leeds, of Stevens Institute, and others, expressed their views and gave testimony to the independence of chemical and bacteriological methods in the study of water supply.

An important point strongly insisted upon by Dr. Sedgwick is the necessity for a personal investigation of the source from which a sample of water is obtained, and he advises the chemist and bacteriologist to refuse to report without personal investigation of the sources of supply.

Durand Woodman,
Secretary.

ERRATUM: P. 658, col. 1, line 25 for *Mesopithecus* read Nesopithecus.